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(12) **United States Patent**
Atay et al.

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(45) **Date of Patent: Sep. 8, 2015**

(54) **METHOD OF USING AN IMAGING DEVICE HAVING A MEDIA STIFFNESS SENSOR ASSEMBLY**

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(73) Assignee: **Lexmark International, Inc.**, Lexington, KY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Dec. 31, 2013**

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(51) **Int. Cl.**

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G03G 15/00	(2006.01)
B65H 7/02	(2006.01)
B65H 43/00	(2006.01)
B65H 9/04	(2006.01)
B65H 7/20	(2006.01)

(52) **U.S. Cl.**

CPC ***G03G 15/5029*** (2013.01); ***B65H 7/02*** (2013.01); *B65H 7/20* (2013.01); *B65H 9/04* (2013.01); *B65H 43/00* (2013.01); *B65H 2511/416* (2013.01); *B65H 2515/10* (2013.01); *B65H 2515/312* (2013.01)

(58) **Field of Classification Search**

CPC B65H 9/04; B65H 7/02; B65H 7/20; B65H 43/00; B65H 2511/416; B65H 2515/312; B65H 2515/10

See application file for complete search history.

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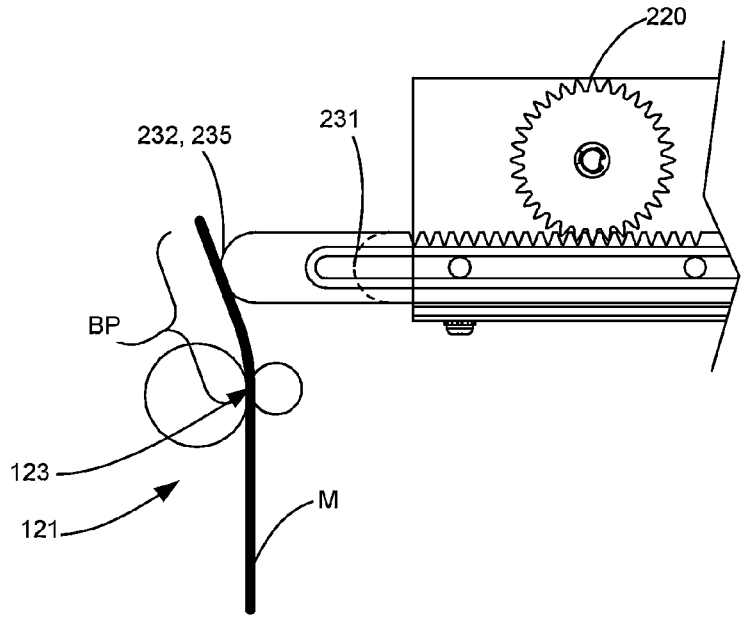
Primary Examiner — Howard Sanders

(74) *Attorney, Agent, or Firm* — John Victor Pezdek

(57) **ABSTRACT**

A method of determining a media weight using a media stiffness sensor in an imaging device. A media sheet is staged having a cantilevered portion which is deflected by a contact member translated into the cantilevered portion. Based on the energy used to move the contact member through a travel distance, a media weight can be determined. An operating parameter of the imaging device may be adjusted based on the media weight that was determined.

25 Claims, 15 Drawing Sheets



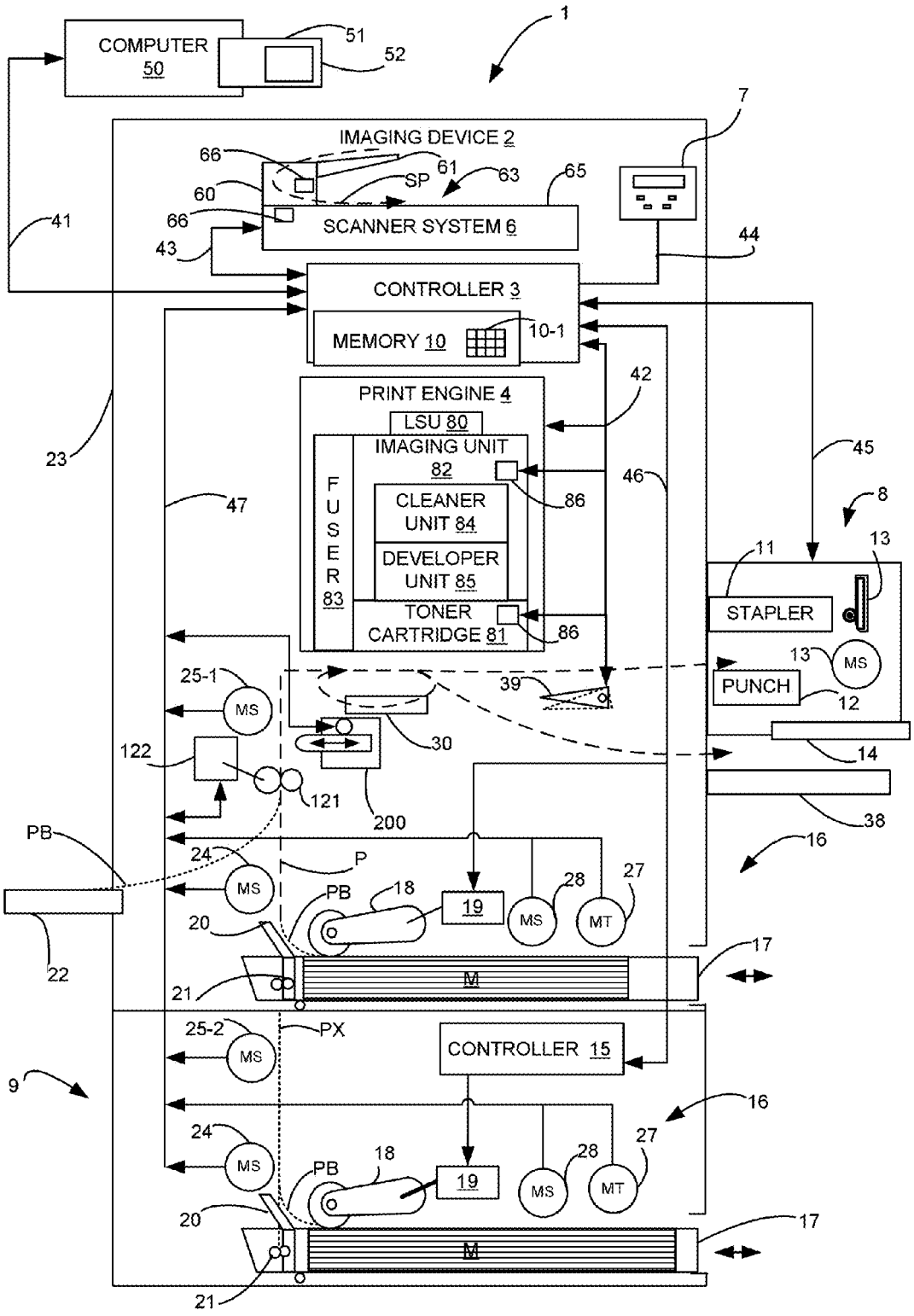
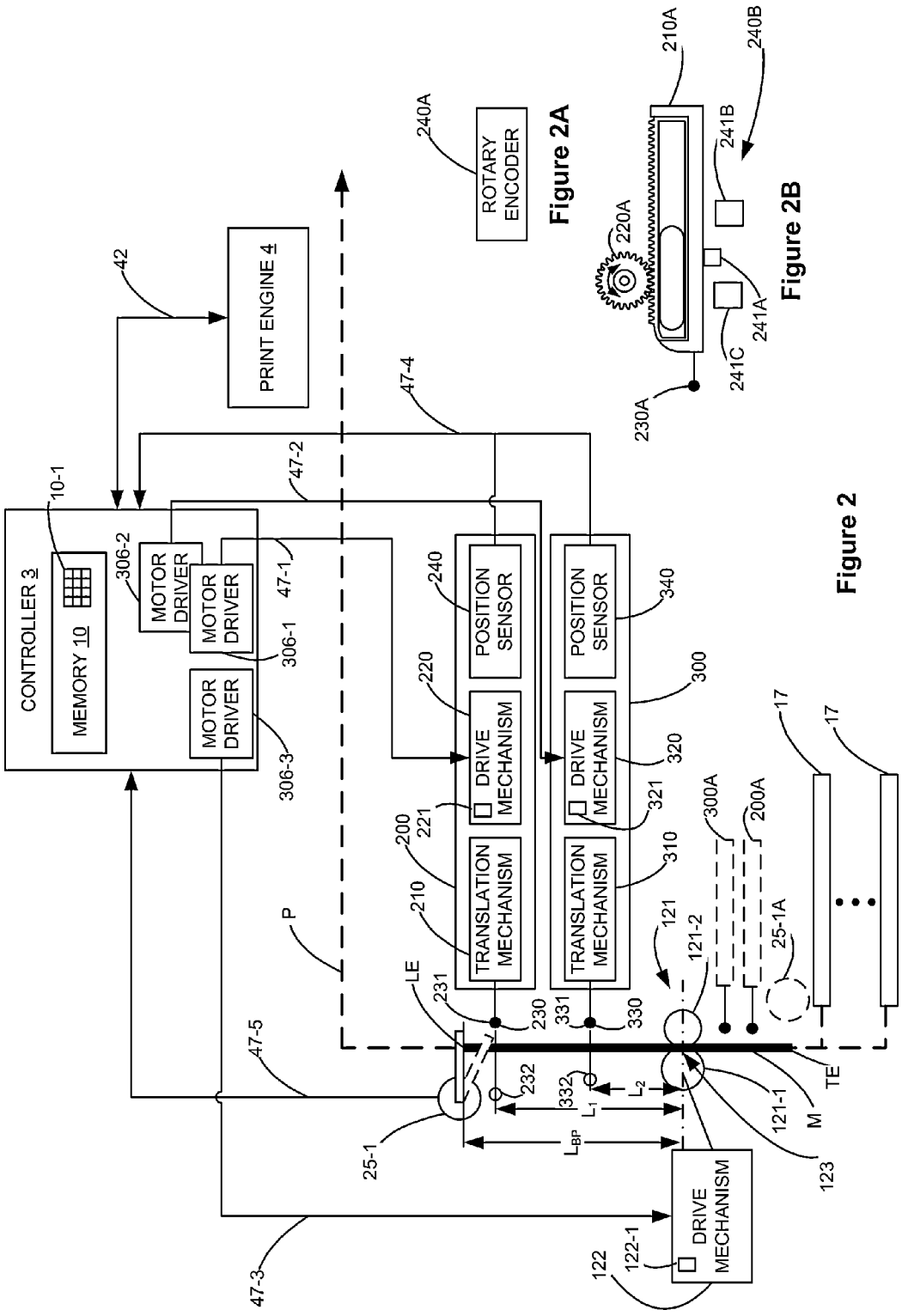

COMPUTER 50
51
52
1
7
IMAGING DEVICE 2
66
61
SP
63
65
60
66
SCANNER SYSTEM 6
41
43
44
CONTROLLER 3
MEMORY 10
10-1
42
PRINT ENGINE 4
LSU 80
IMAGING UNIT 82
FUSER 83
CLEANER UNIT 84
DEVELOPER UNIT 85
TONER CARTRIDGE 81
86
23
47
46
45
8
11
13
STAPLER
PUNCH
12
14
38
16
25-1
MS
39
30
122
121
200
PB
24
P
18
19
28
27
MT
20
22
21
M
17
25-2
PX
CONTROLLER 15
9

Figure 1


CONTROLLER 3
MEMORY 10
10-1
MOTOR DRIVER
MOTOR DRIVER
MOTOR DRIVER
306-2
306-1
306-3
47-1
47-2
47-3
47-4
47-5
42
PRINT ENGINE 4
ROTARY ENCODER
240A
POSITION SENSOR
POSITION SENSOR
240
340
DRIVE MECHANISM
DRIVE MECHANISM
220
320
300
TRANSLATION MECHANISM
TRANSLATION MECHANISM
210
310
200
221
321
DRIVE MECHANISM
122
122-1
P
LE
231
230
331
330
232
332
L_1
L_2
L_{BP}
25-1
121
121-2
25-1A
300A
200A
17
17
TE
M
121-1
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210A
240B
241B
220A
241A
241C
230A
Figure 2A
Figure 2B
Figure 2

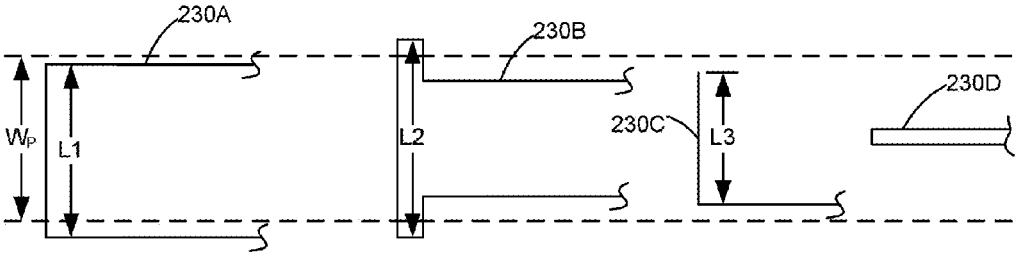


Figure 3A Figure 3B Figure 3C Figure 3D

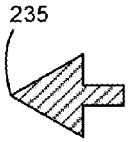


Figure 4A

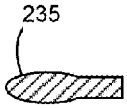


Figure 4B

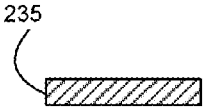


Figure 4C

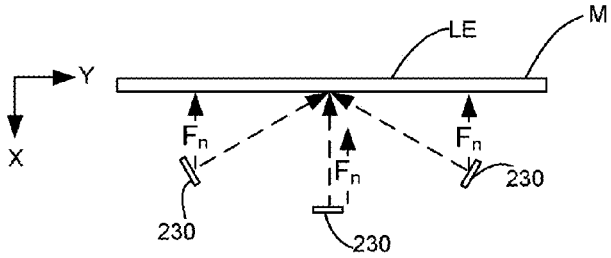
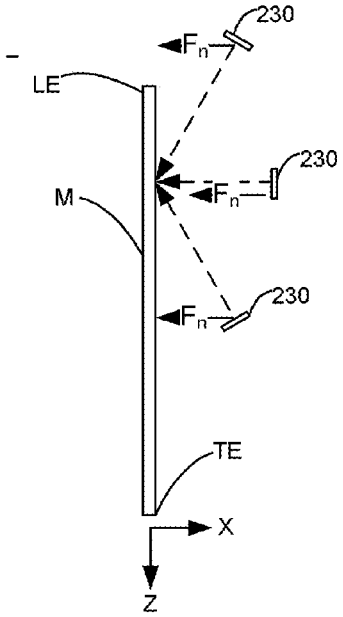


Figure 5A



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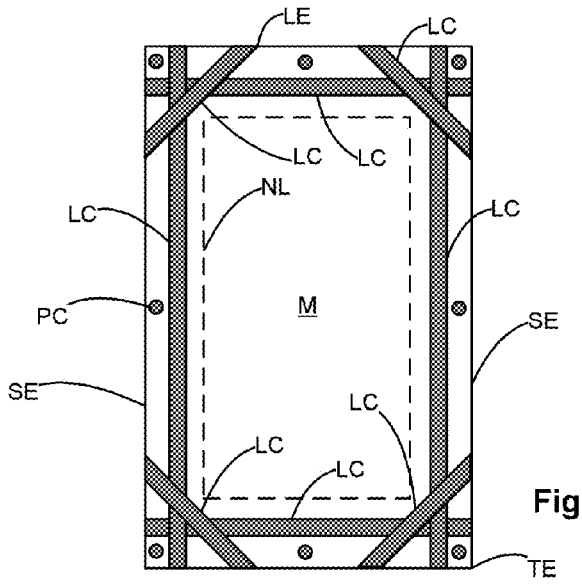

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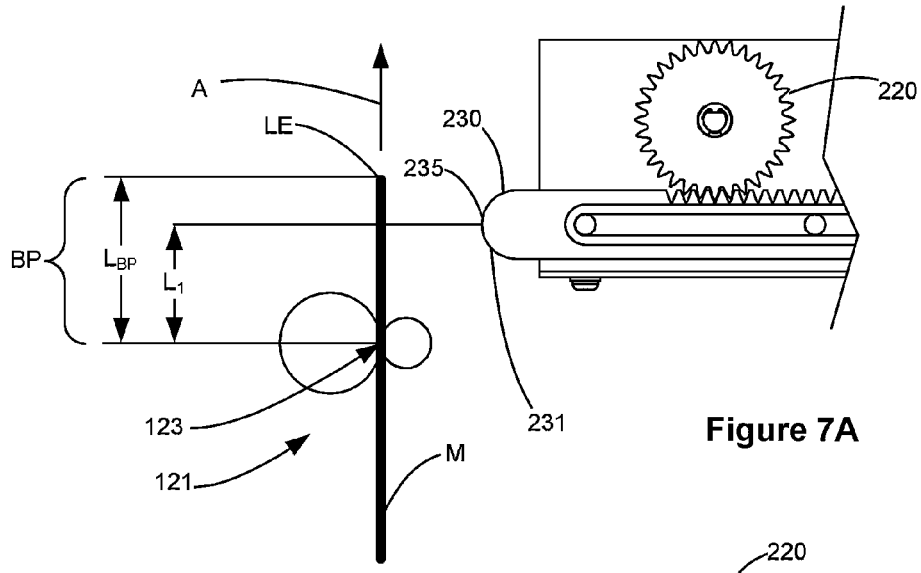


Figure 7A

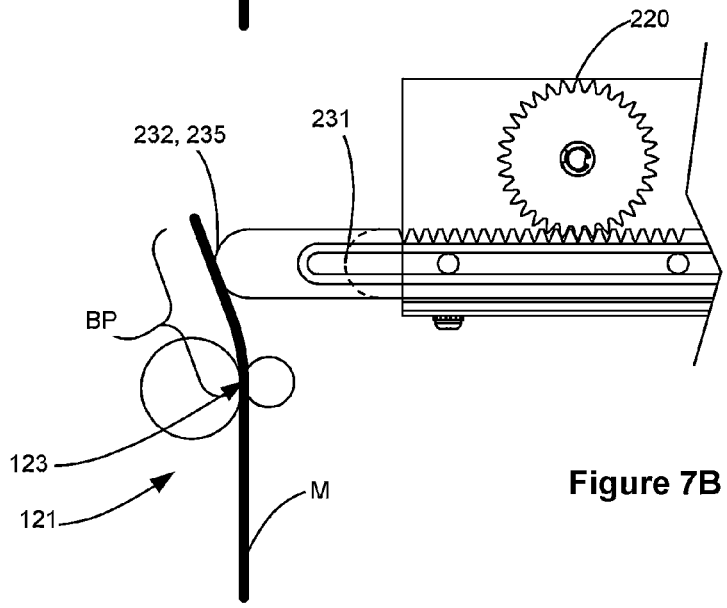
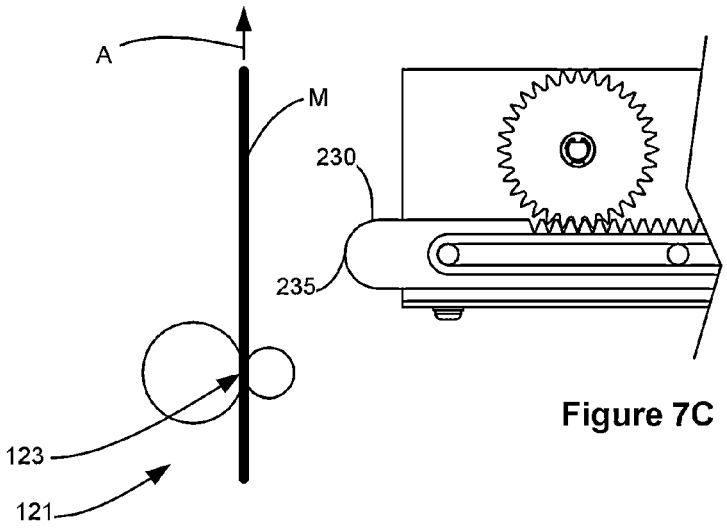


Figure 7B



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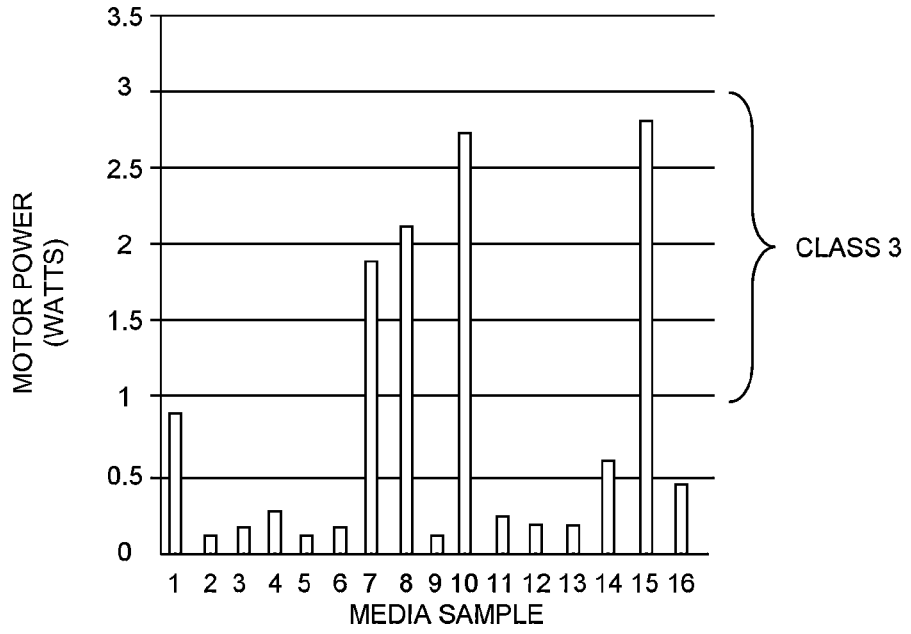

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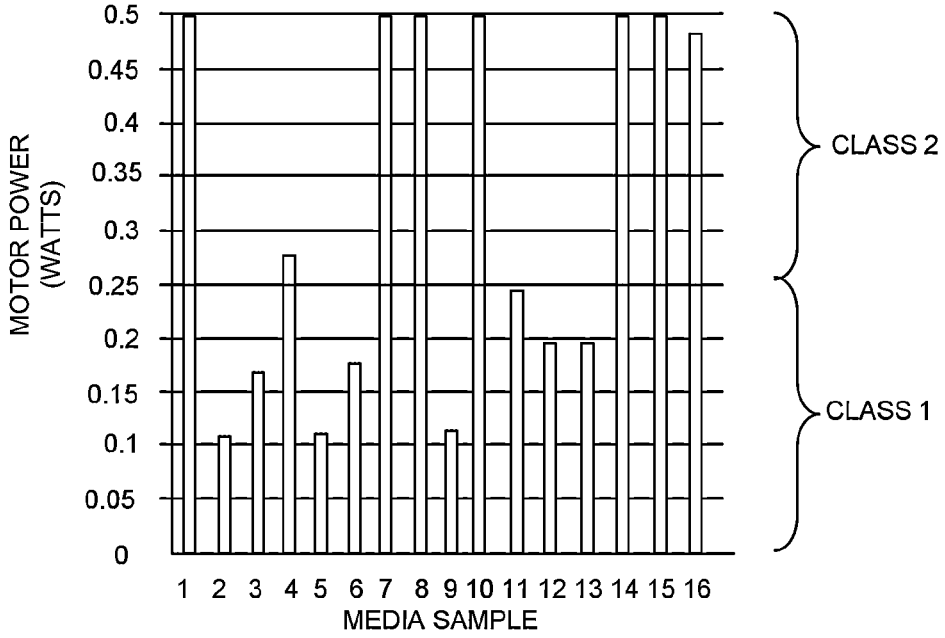

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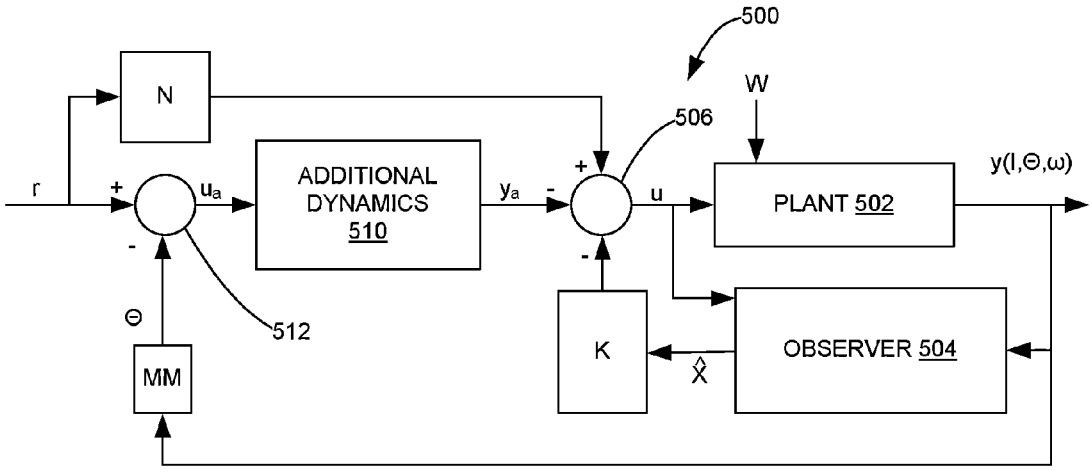

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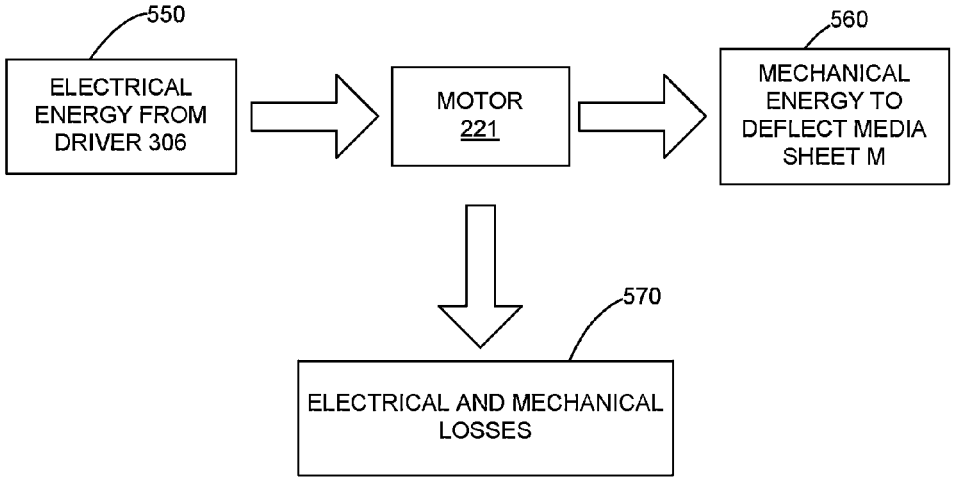

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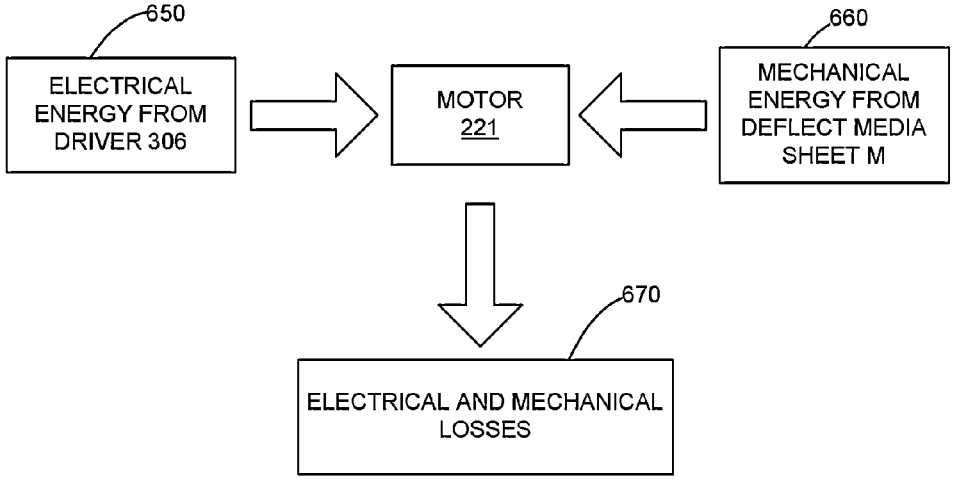

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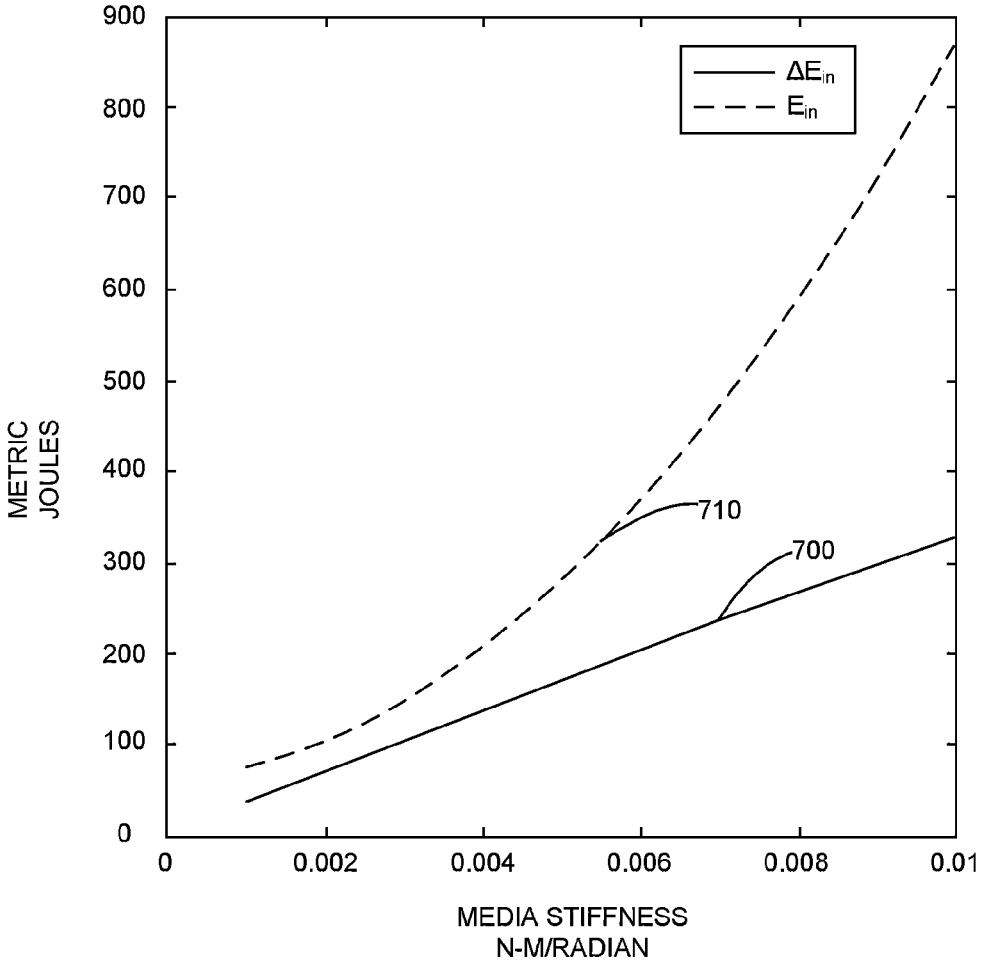

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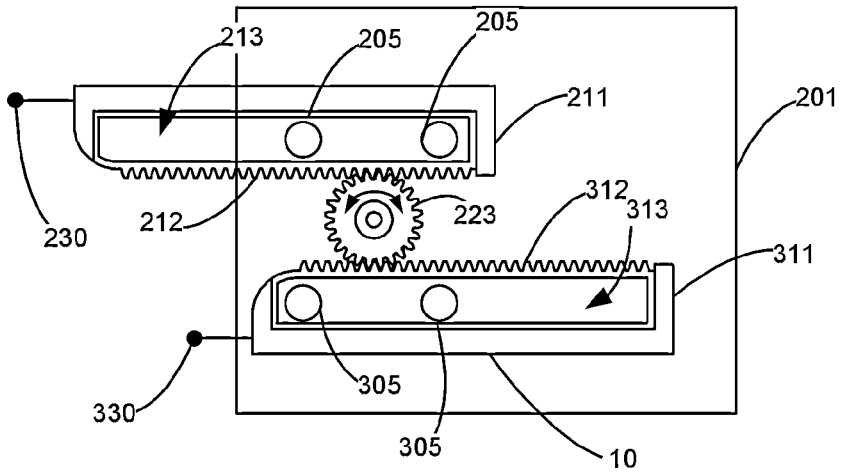

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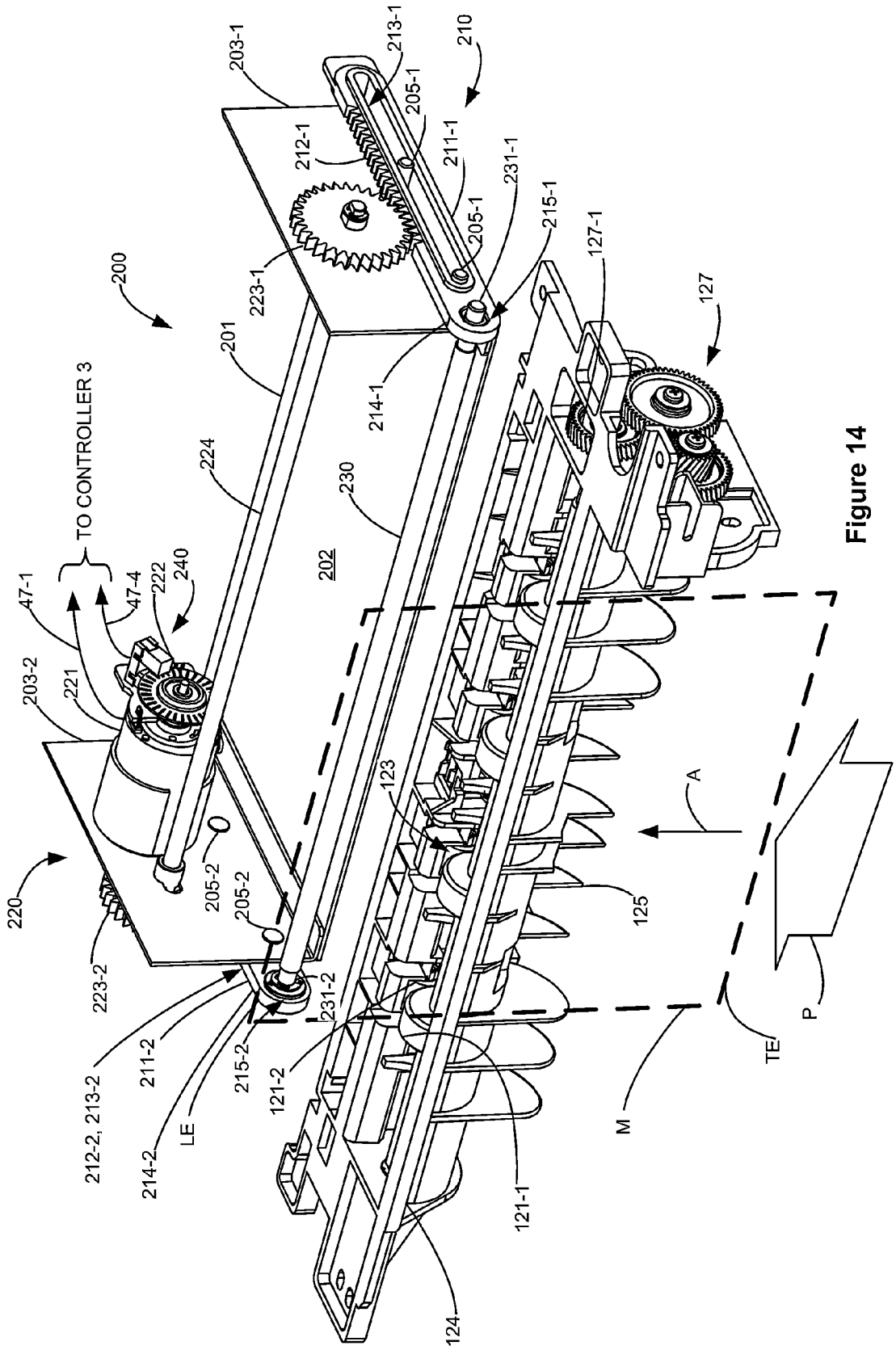
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201
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215-2
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221
222
223-1
223-2
224
230
231-1
231-2
240
47-1
47-4
TO CONTROLLER 3
121-1
121-2
123
124
125
127
127-1
LE
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P
A

Figure 14

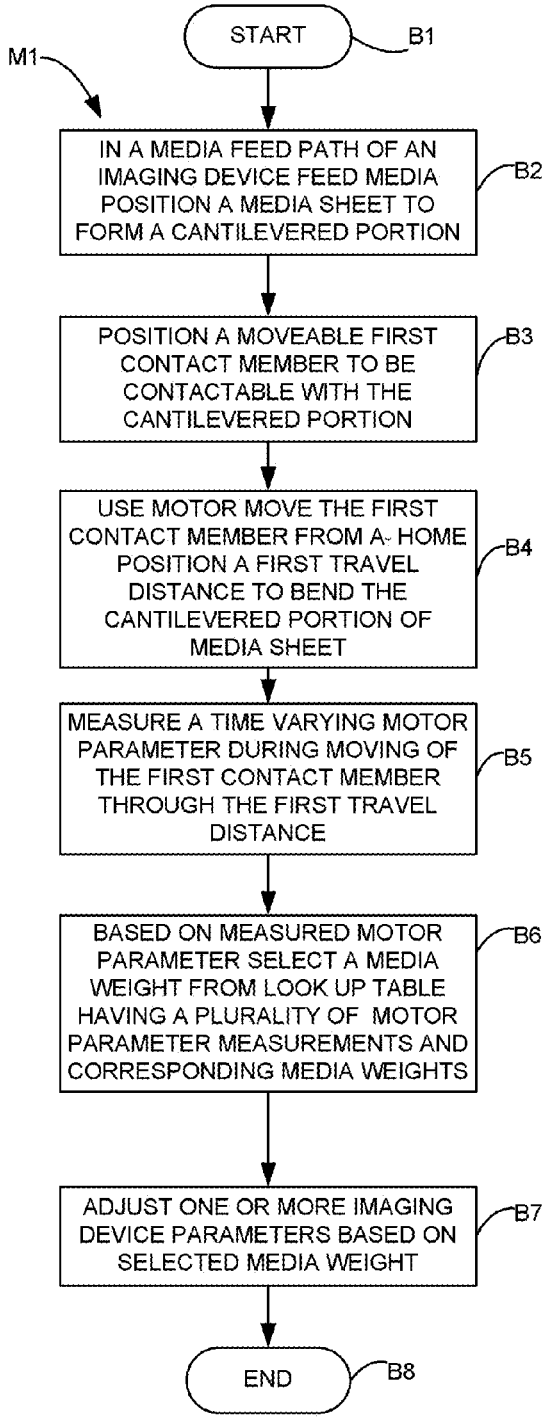
START
B1
M1
IN A MEDIA FEED PATH OF AN IMAGING DEVICE FEED MEDIA POSITION A MEDIA SHEET TO FORM A CANTILEVERED PORTION
B2
POSITION A MOVEABLE FIRST CONTACT MEMBER TO BE CONTACTABLE WITH THE CANTILEVERED PORTION
B3
USE MOTOR MOVE THE FIRST CONTACT MEMBER FROM A HOME POSITION A FIRST TRAVEL DISTANCE TO BEND THE CANTILEVERED PORTION OF MEDIA SHEET
B4
MEASURE A TIME VARYING MOTOR PARAMETER DURING MOVING OF THE FIRST CONTACT MEMBER THROUGH THE FIRST TRAVEL DISTANCE
B5
BASED ON MEASURED MOTOR PARAMETER SELECT A MEDIA WEIGHT FROM LOOK UP TABLE HAVING A PLURALITY OF MOTOR PARAMETER MEASUREMENTS AND CORRESPONDING MEDIA WEIGHTS
B6
ADJUST ONE OR MORE IMAGING DEVICE PARAMETERS BASED ON SELECTED MEDIA WEIGHT
B7
END
B8

Figure 16

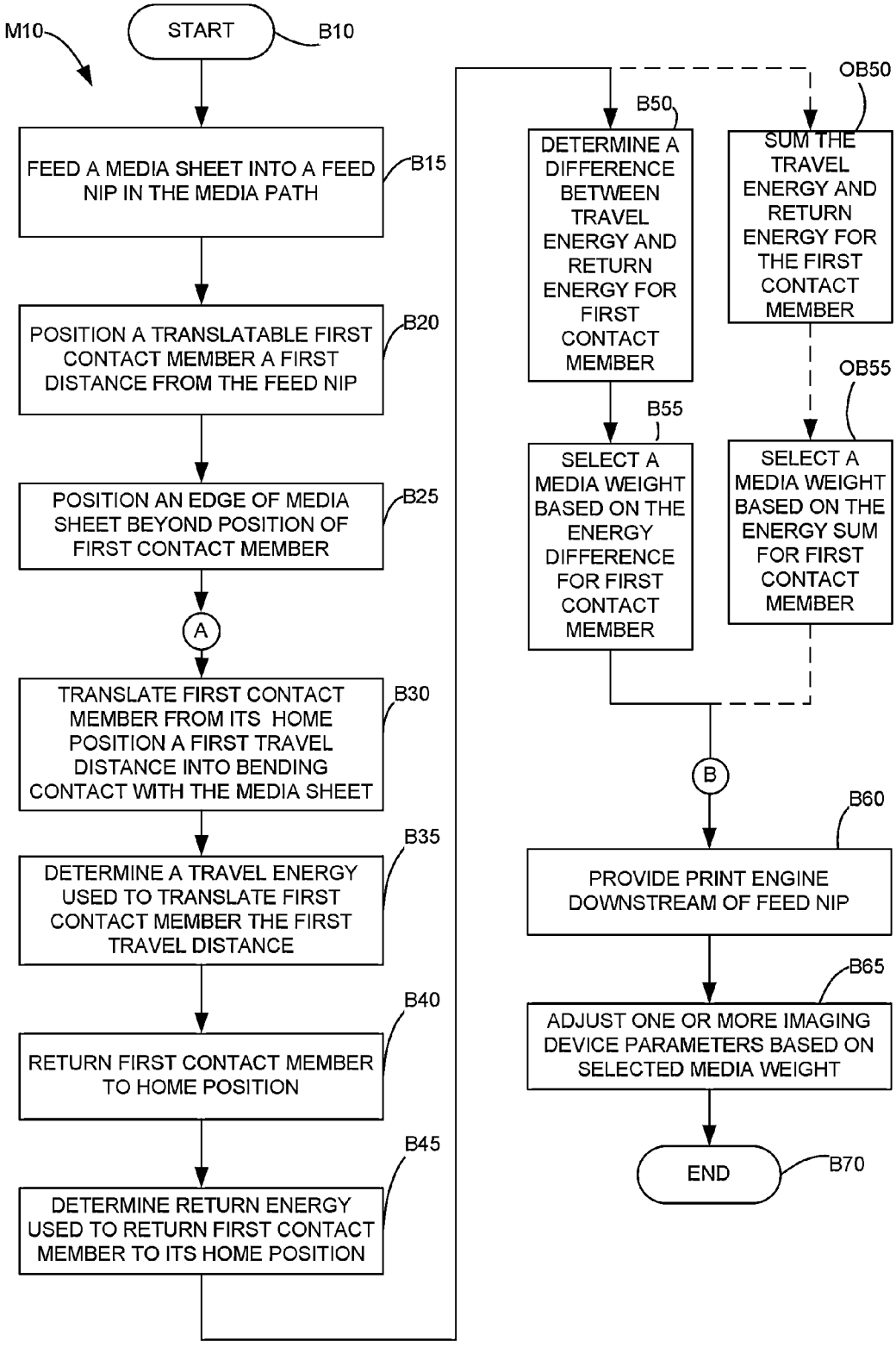
M10
START
B10
FEED A MEDIA SHEET INTO A FEED NIP IN THE MEDIA PATH
B15
POSITION A TRANSLATABLE FIRST CONTACT MEMBER A FIRST DISTANCE FROM THE FEED NIP
B20
POSITION AN EDGE OF MEDIA SHEET BEYOND POSITION OF FIRST CONTACT MEMBER
B25
A
TRANSLATE FIRST CONTACT MEMBER FROM ITS HOME POSITION A FIRST TRAVEL DISTANCE INTO BENDING CONTACT WITH THE MEDIA SHEET
B30
DETERMINE A TRAVEL ENERGY USED TO TRANSLATE FIRST CONTACT MEMBER THE FIRST TRAVEL DISTANCE
B35
RETURN FIRST CONTACT MEMBER TO HOME POSITION
B40
DETERMINE RETURN ENERGY USED TO RETURN FIRST CONTACT MEMBER TO ITS HOME POSITION
B45
OB50
B50
DETERMINE A DIFFERENCE BETWEEN TRAVEL ENERGY AND RETURN ENERGY FOR FIRST CONTACT MEMBER
SUM THE TRAVEL ENERGY AND RETURN ENERGY FOR THE FIRST CONTACT MEMBER
OB55
B55
SELECT A MEDIA WEIGHT BASED ON THE ENERGY DIFFERENCE FOR FIRST CONTACT MEMBER
SELECT A MEDIA WEIGHT BASED ON THE ENERGY SUM FOR FIRST CONTACT MEMBER
B
B60
PROVIDE PRINT ENGINE DOWNSTREAM OF FEED NIP
B65
ADJUST ONE OR MORE IMAGING DEVICE PARAMETERS BASED ON SELECTED MEDIA WEIGHT
END
B70

Figure 17

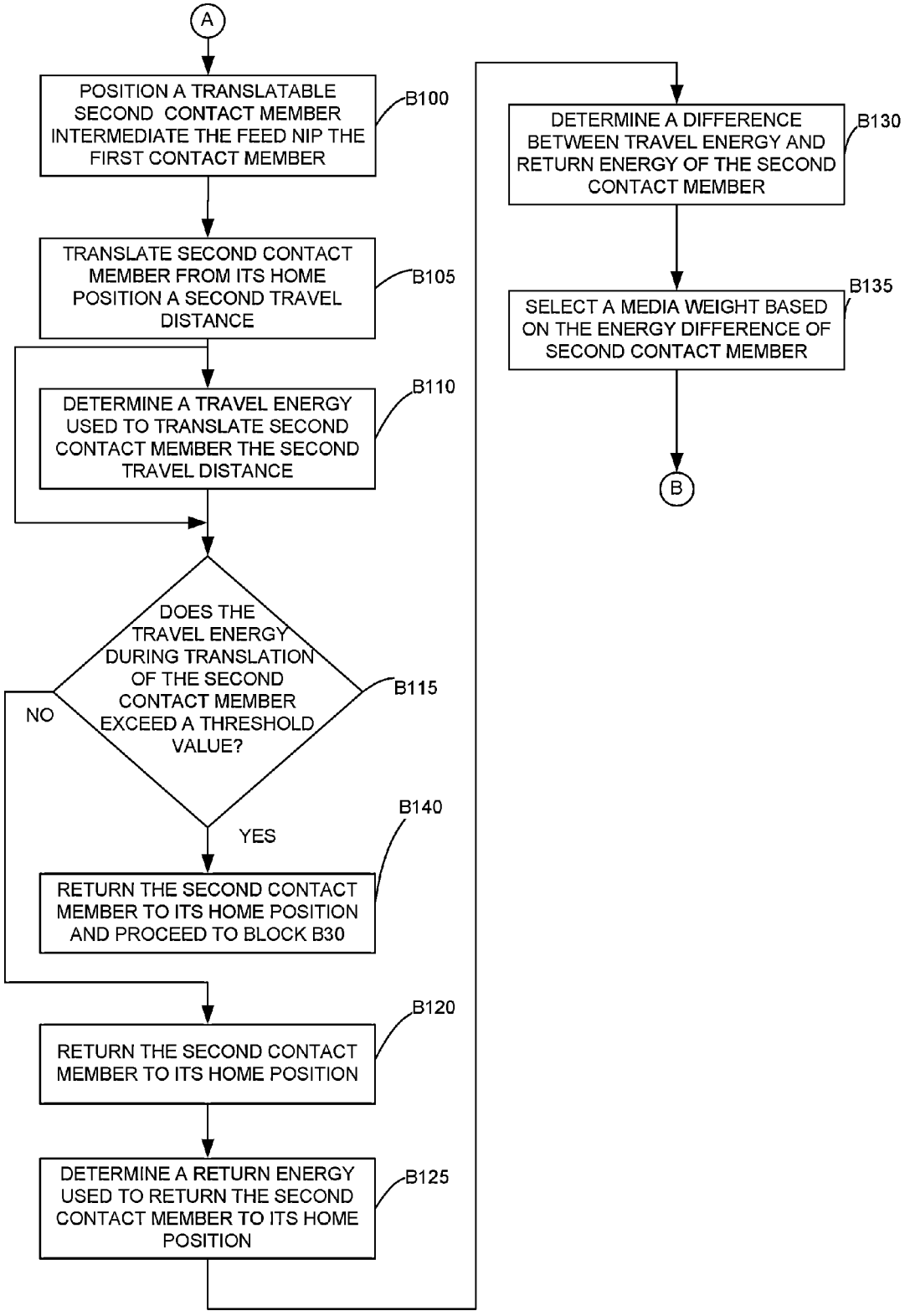
A
POSITION A TRANSLATABLE SECOND CONTACT MEMBER INTERMEDIATE THE FEED NIP THE FIRST CONTACT MEMBER
B100
TRANSLATE SECOND CONTACT MEMBER FROM ITS HOME POSITION A SECOND TRAVEL DISTANCE
B105
DETERMINE A TRAVEL ENERGY USED TO TRANSLATE SECOND CONTACT MEMBER THE SECOND TRAVEL DISTANCE
B110
DOES THE TRAVEL ENERGY DURING TRANSLATION OF THE SECOND CONTACT MEMBER EXCEED A THRESHOLD VALUE?
B115
NO
YES
RETURN THE SECOND CONTACT MEMBER TO ITS HOME POSITION AND PROCEED TO BLOCK B30
B140
RETURN THE SECOND CONTACT MEMBER TO ITS HOME POSITION
B120
DETERMINE A RETURN ENERGY USED TO RETURN THE SECOND CONTACT MEMBER TO ITS HOME POSITION
B125
DETERMINE A DIFFERENCE BETWEEN TRAVEL ENERGY AND RETURN ENERGY OF THE SECOND CONTACT MEMBER
B130
SELECT A MEDIA WEIGHT BASED ON THE ENERGY DIFFERENCE OF SECOND CONTACT MEMBER
B135
B

Figure 18

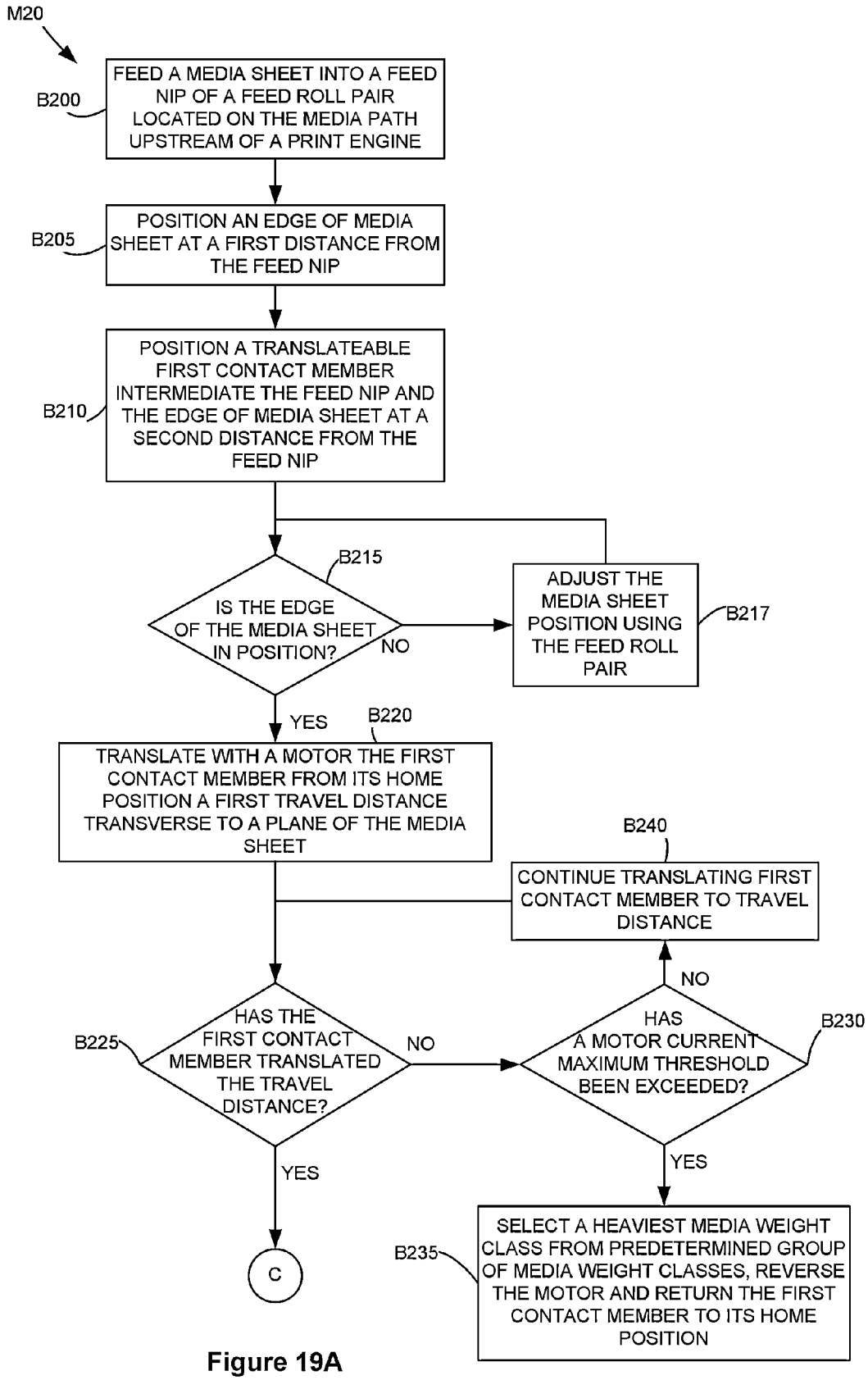
M20
B200
FEED A MEDIA SHEET INTO A FEED NIP OF A FEED ROLL PAIR LOCATED ON THE MEDIA PATH UPSTREAM OF A PRINT ENGINE
B205
POSITION AN EDGE OF MEDIA SHEET AT A FIRST DISTANCE FROM THE FEED NIP
B210
POSITION A TRANSLATEABLE FIRST CONTACT MEMBER INTERMEDIATE THE FEED NIP AND THE EDGE OF MEDIA SHEET AT A SECOND DISTANCE FROM THE FEED NIP
B215
IS THE EDGE OF THE MEDIA SHEET IN POSITION?
NO
ADJUST THE MEDIA SHEET POSITION USING THE FEED ROLL PAIR
B217
YES
B220
TRANSLATE WITH A MOTOR THE FIRST CONTACT MEMBER FROM ITS HOME POSITION A FIRST TRAVEL DISTANCE TRANSVERSE TO A PLANE OF THE MEDIA SHEET
B240
CONTINUE TRANSLATING FIRST CONTACT MEMBER TO TRAVEL DISTANCE
NO
B225
HAS THE FIRST CONTACT MEMBER TRANSLATED THE TRAVEL DISTANCE?
NO
HAS A MOTOR CURRENT MAXIMUM THRESHOLD BEEN EXCEEDED?
B230
YES
YES
C
B235
SELECT A HEAVIEST MEDIA WEIGHT CLASS FROM PREDETERMINED GROUP OF MEDIA WEIGHT CLASSES, REVERSE THE MOTOR AND RETURN THE FIRST CONTACT MEMBER TO ITS HOME POSITION

Figure 19A

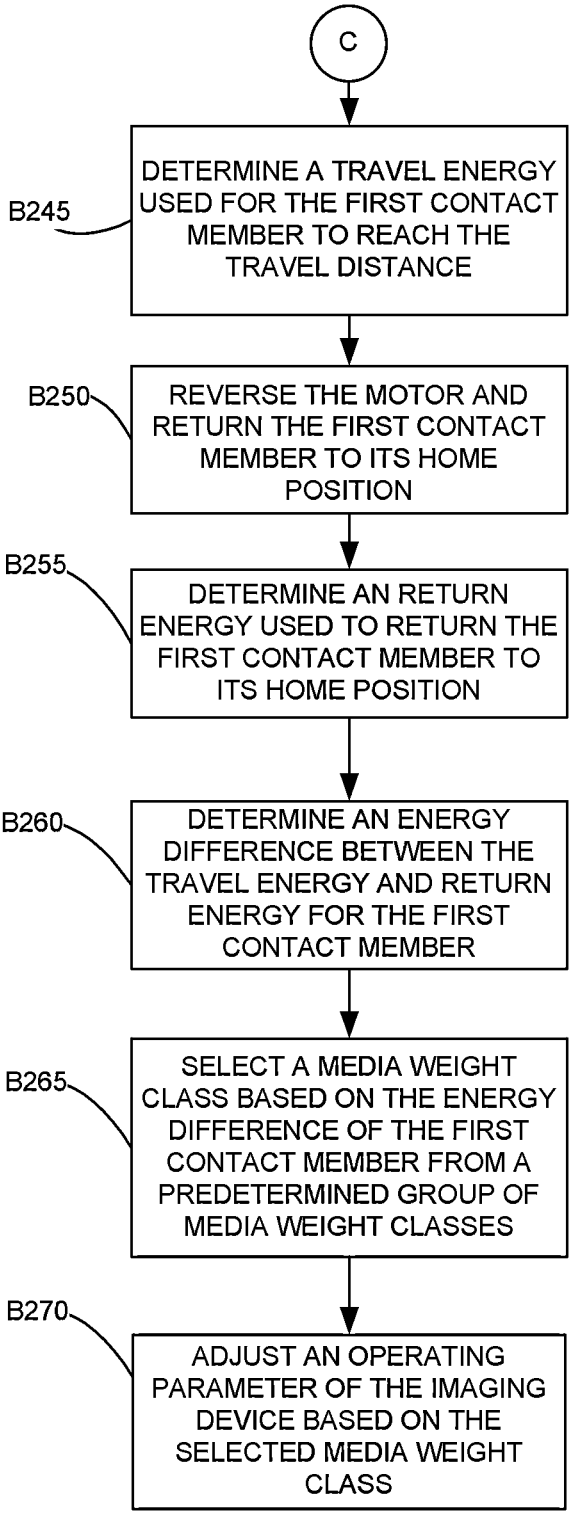
C
B245
DETERMINE A TRAVEL ENERGY USED FOR THE FIRST CONTACT MEMBER TO REACH THE TRAVEL DISTANCE
B250
REVERSE THE MOTOR AND RETURN THE FIRST CONTACT MEMBER TO ITS HOME POSITION
B255
DETERMINE AN RETURN ENERGY USED TO RETURN THE FIRST CONTACT MEMBER TO ITS HOME POSITION
B260
DETERMINE AN ENERGY DIFFERENCE BETWEEN THE TRAVEL ENERGY AND RETURN ENERGY FOR THE FIRST CONTACT MEMBER
B265
SELECT A MEDIA WEIGHT CLASS BASED ON THE ENERGY DIFFERENCE OF THE FIRST CONTACT MEMBER FROM A PREDETERMINED GROUP OF MEDIA WEIGHT CLASSES
B270
ADJUST AN OPERATING PARAMETER OF THE IMAGING DEVICE BASED ON THE SELECTED MEDIA WEIGHT CLASS

Figure 19B

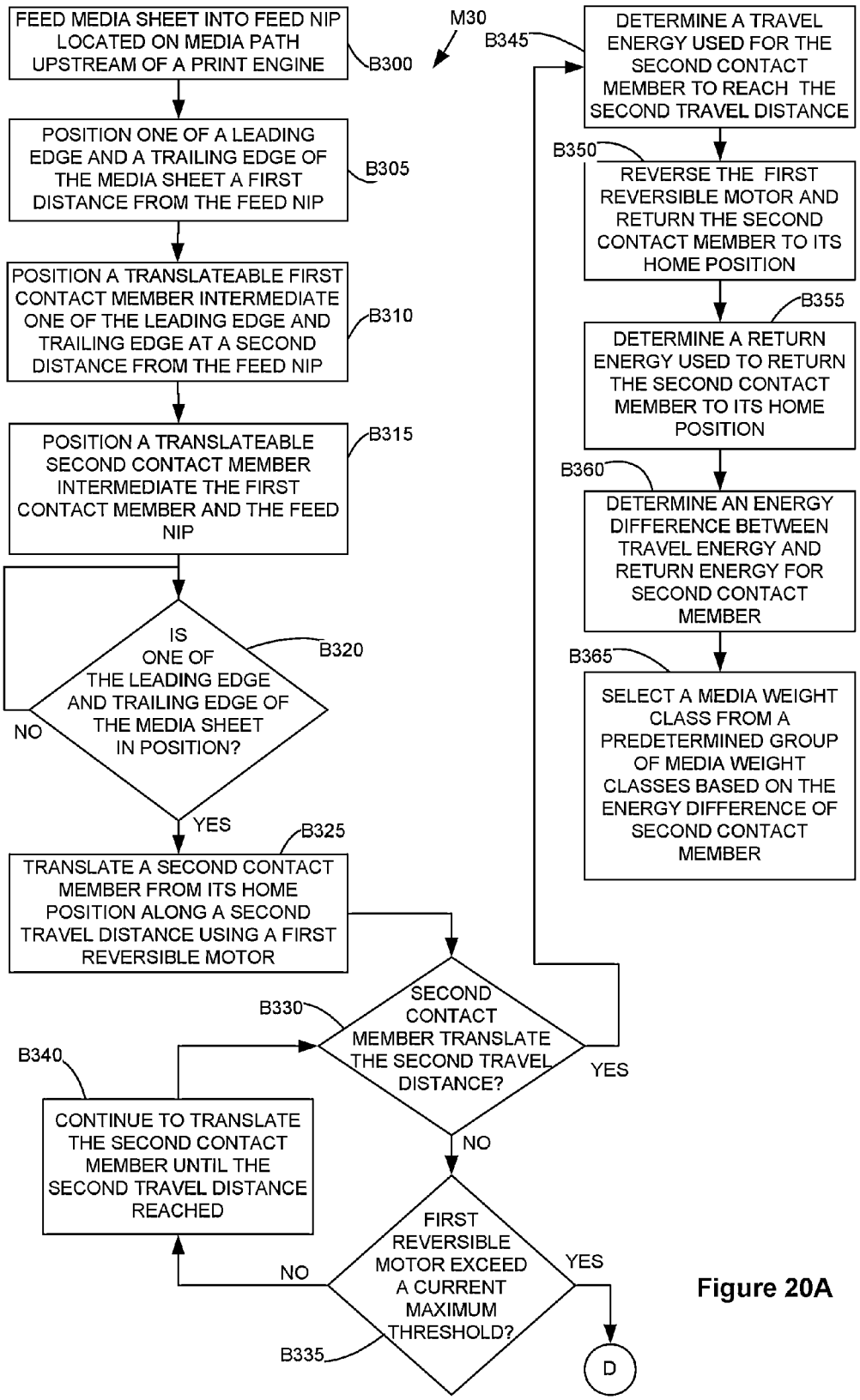
FEED MEDIA SHEET INTO FEED NIP LOCATED ON MEDIA PATH UPSTREAM OF A PRINT ENGINE
B300
POSITION ONE OF A LEADING EDGE AND A TRAILING EDGE OF THE MEDIA SHEET A FIRST DISTANCE FROM THE FEED NIP
B305
POSITION A TRANSLATEABLE FIRST CONTACT MEMBER INTERMEDIATE ONE OF THE LEADING EDGE AND TRAILING EDGE AT A SECOND DISTANCE FROM THE FEED NIP
B310
POSITION A TRANSLATEABLE SECOND CONTACT MEMBER INTERMEDIATE THE FIRST CONTACT MEMBER AND THE FEED NIP
B315
IS ONE OF THE LEADING EDGE AND TRAILING EDGE OF THE MEDIA SHEET IN POSITION?
B320
NO
YES
TRANSLATE A SECOND CONTACT MEMBER FROM ITS HOME POSITION ALONG A SECOND TRAVEL DISTANCE USING A FIRST REVERSIBLE MOTOR
B325
SECOND CONTACT MEMBER TRANSLATE THE SECOND TRAVEL DISTANCE?
B330
YES
NO
CONTINUE TO TRANSLATE THE SECOND CONTACT MEMBER UNTIL THE SECOND TRAVEL DISTANCE REACHED
B340
FIRST REVERSIBLE MOTOR EXCEED A CURRENT MAXIMUM THRESHOLD?
B335
NO
YES
D
M30
DETERMINE A TRAVEL ENERGY USED FOR THE SECOND CONTACT MEMBER TO REACH THE SECOND TRAVEL DISTANCE
B345
REVERSE THE FIRST REVERSIBLE MOTOR AND RETURN THE SECOND CONTACT MEMBER TO ITS HOME POSITION
B350
DETERMINE A RETURN ENERGY USED TO RETURN THE SECOND CONTACT MEMBER TO ITS HOME POSITION
B355
DETERMINE AN ENERGY DIFFERENCE BETWEEN TRAVEL ENERGY AND RETURN ENERGY FOR SECOND CONTACT MEMBER
B360
SELECT A MEDIA WEIGHT CLASS FROM A PREDETERMINED GROUP OF MEDIA WEIGHT CLASSES BASED ON THE ENERGY DIFFERENCE OF SECOND CONTACT MEMBER
B365

Figure 20A

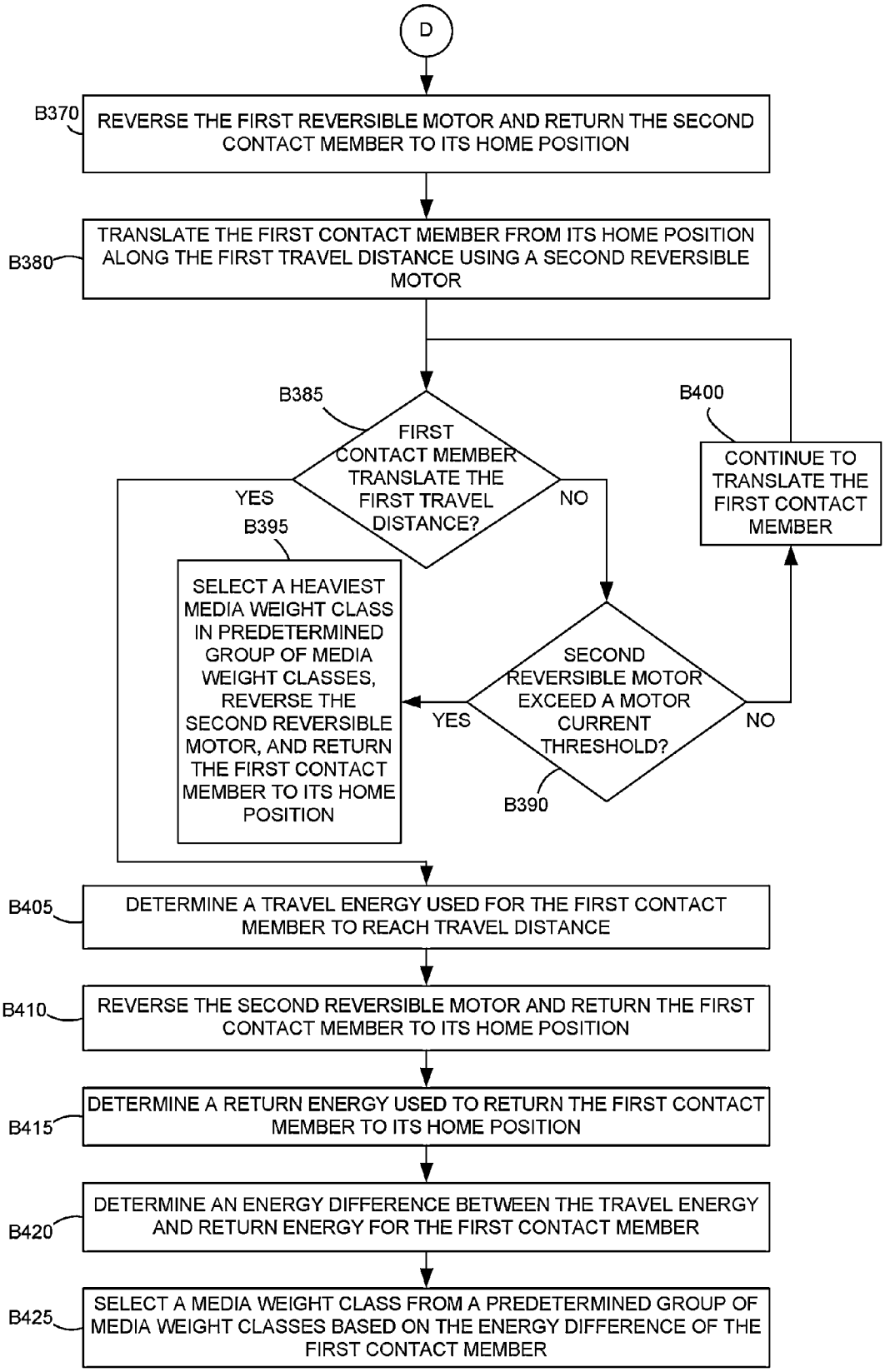
D
B370
REVERSE THE FIRST REVERSIBLE MOTOR AND RETURN THE SECOND CONTACT MEMBER TO ITS HOME POSITION
B380
TRANSLATE THE FIRST CONTACT MEMBER FROM ITS HOME POSITION ALONG THE FIRST TRAVEL DISTANCE USING A SECOND REVERSIBLE MOTOR
B385
FIRST CONTACT MEMBER TRANSLATE THE FIRST TRAVEL DISTANCE?
YES
NO
B400
CONTINUE TO TRANSLATE THE FIRST CONTACT MEMBER
B395
SELECT A HEAVIEST MEDIA WEIGHT CLASS IN PREDETERMINED GROUP OF MEDIA WEIGHT CLASSES, REVERSE THE SECOND REVERSIBLE MOTOR, AND RETURN THE FIRST CONTACT MEMBER TO ITS HOME POSITION
SECOND REVERSIBLE MOTOR EXCEED A MOTOR CURRENT THRESHOLD?
YES
NO
B390
B405
DETERMINE A TRAVEL ENERGY USED FOR THE FIRST CONTACT MEMBER TO REACH TRAVEL DISTANCE
B410
REVERSE THE SECOND REVERSIBLE MOTOR AND RETURN THE FIRST CONTACT MEMBER TO ITS HOME POSITION
B415
DETERMINE A RETURN ENERGY USED TO RETURN THE FIRST CONTACT MEMBER TO ITS HOME POSITION
B420
DETERMINE AN ENERGY DIFFERENCE BETWEEN THE TRAVEL ENERGY AND RETURN ENERGY FOR THE FIRST CONTACT MEMBER
B425
SELECT A MEDIA WEIGHT CLASS FROM A PREDETERMINED GROUP OF MEDIA WEIGHT CLASSES BASED ON THE ENERGY DIFFERENCE OF THE FIRST CONTACT MEMBER

Figure 20B

METHOD OF USING AN IMAGING DEVICE HAVING A MEDIA STIFFNESS SENSOR ASSEMBLY

CROSS REFERENCES TO RELATED APPLICATIONS

This patent application is related to U.S. patent application Ser. No. 14/145,601, filed Dec. 31, 2013, entitled "MEDIA STIFFNESS SENSOR ASSEMBLY FOR AN IMAGING DEVICE" and assigned to the assignee of the present application.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None.

REFERENCE TO SEQUENTIAL LISTING, ETC.

None.

BACKGROUND

1. Field of the Disclosure

The present disclosure relates generally to imaging device media sensors and methods of using the same, and more particularly to media stiffness sensors and methods of using the same.

2. Description of the Related Art

Currently, most imaging devices require user to input media type, weight, and texture. However, most users do not adjust media settings. Of those that do adjust settings, only a small percentage correctly classify media. Failure to correctly set media properties results in print quality defects, poor fuse grade, and higher jam rates. Also, this leads to a higher number of service calls, visits, and replacement part rates.

Incorrectly setting media weight is a major contributor to these higher failure rates. If the media weight is set too low, the printer runs too fast, transfer voltages are set too low, and fuser temperatures are set too low. If the media weight is set too high, the printer runs too slow, transfer voltages are set too high, and fuser temperatures are set too high. Poor print quality is a result along with premature hardware failures.

In particular, light weight media set at a normal or a heavy weight has a much higher likelihood to wrap a fuser, particularly, when printing higher coverage pages. Too much heat is provided and the toner hot offsets. Because the trend is towards using lighter weight media with more refined (recycled) fiber content, this problem will become more prevalent.

Additionally, heavy weight media set at normal or light weight does not adequately melt the toner and cold offset occurs. This allows unattached toner to deposit on the fuser backup roll and be carried downstream where it contaminates paper guides and creates catch points. This results in a higher likelihood for jams, fuser being wrapped by media (fuse wraps), and machine damage on subsequent jobs. Ultimately, if media is run at an improper weight setting, user satisfaction suffers.

A number of sensors that loosely correlate to stiffness or thickness are available. These include methods based upon wave/pulse transmission (optical, acoustic, microwave, etc.), visual thickness inspection (cameras mounted in a tray, etc.), and monitoring feed or pick motor current. Energy transmittance methods typically have difficulty distinguishing between very light and normal weight media; these methods also have broader standard deviations when the media is more porous, is dual-web, or has a watermark. Visual thickness inspection would require camera electronics and hardware to be placed in each media input and image processing algorithms would be needed to interpret the data captured. Feed motor and pick motor current signals are inherently noisy; the current is dependent upon sheet friction, bending stiffness, and the dynamic behavior of the sheet.

It would be desirable to have a sensor and method that avoids the aforementioned drawbacks and provides an automatic determination of a media weight of a sheet of media as it is being fed along a media feed path in an imaging device prior to being imaged. It would additionally be desirable to be able to adjust an operating parameter of the imaging device based on the selected media weight.

SUMMARY

A method for determining a media weight of a media sheet being fed along a media path of an imaging device is disclosed. The method comprises positioning a media sheet in the media path to form a cantilevered portion, positioning a moveable first contact member to be contactable with the cantilevered portion of the media sheet, using a motor to move the first contact member from a home position thereof through a travel distance to bend the cantilevered portion of the media sheet, measuring a time varying motor parameter during moving of the first contact member through the first travel distance, and selecting, based on the measured motor parameter a media weight. The time varying motor parameter is one of a motor peak current, a motor root mean square current, a travel energy used to move the first contact member through the travel distance, a rate of change of motor current with respect to displacement of the first contact member, a rate of change of motor current with respect to time of movement of the first contact member through the travel distance, a rate of change of motor voltage with respect to displacement of the first contact member, and a rate of change of motor voltage with respect to time of movement of the first contact member through the travel distance.

In a further form, the method comprises feeding a media sheet into a nip formed between a pair of feed rolls positioned along the media path; positioning a translateable first contact member at a first distance from the nip; positioning an edge of the media sheet beyond the position of the first contact member at a second distance from the nip that is greater than the first distance; translating the first contact member from a home position thereof a first travel distance into contact with the media sheet; determining an amount of travel energy used to translate the first contact member the first travel distance; returning the first contact member to the home position thereof; determining the amount of return energy used to return the first contact member to the home position thereof; determining an energy amount based on the amounts of travel energy and return energy for the first contact member; and selecting, based on the energy amount for the first contact member, a media weight.

The media weight may be a media weight class selected from a plurality of predetermined plurality of media weight classes or may be one media weight selected from a predetermined continuum of media weights. Upon determining the media weight, at least one operating parameter of the imaging device may be adjusted. The operating parameters that may be adjusted may include, but are not limited to, a media speed

within the print engine, a duplex control scheme, a fuser temperature, a transfer voltage, an output location, and a finishing process.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of the disclosed embodiments, and the manner of attaining them, will become more apparent and will be better understood by reference to the following description of the disclosed embodiments in conjunction with the accompanying drawings.

FIG. **1** is a schematic illustration of an imaging system including an imaging device.

FIG. **2** is a schematic illustration of a system utilizing the presently disclosed sensor assembly according to one example embodiment.

FIGS. **2**A-**2**B illustrate various position sensor configurations for the sensor assembly of FIG. **2**.

FIGS. **3**A-**3**D illustrate various examples of contact member configurations for use in a stiffness sensor assembly.

FIGS. **4**A-**4**C illustrate various contact member cross-sectional shapes.

FIGS. **5**A-**5**B illustrate various approach angles of the contact member with respect to the plane of the media sheet.

FIG. **6** illustrates various contact regions on a media sheet that may be used when measuring media stiffness.

FIGS. **7**A-**7**C illustrate a measurement cycle using the system of FIG. **2** where FIG. **7**A depicts staging of a media sheet; FIG. **7**B depicts the bending of the media sheet by the media stiffness sensor assembly and FIG. **7**C depicts the exiting of the media sheet from the system upon completion of a measurement cycle.

FIGS. **8**-**9** illustrate the relationship between motor power used in bending cycles for stiffness measurement of various media weight classes with three classes indicated where FIG. **8** illustrates the motor power of both lighter and heavier weight media classes while FIG. **9** uses an expanded Y-axis scale to better distinguish the motor power needed for stiffness measurements of lighter weight media shown in FIG. **8**.

FIG. **10** is a block diagram of closed loop control system for a drive mechanism.

FIGS. **11**-**12** respectively illustrate the energy balance of the sensor assembly when translating to the travel distance and returning to the home position.

FIG. **13** is a graph showing two curves, one showing the linear relationship of media stiffness to the difference between travel energy and return energy during a measurement cycle and the other showing the nonlinear relationship between stiffness and total energy input during a measurement cycle.

FIG. **14** is one example embodiment of the presently disclosed stiffness sensor assembly.

FIG. **15** is another example embodiment of the presently disclosed stiffness sensor assembly utilizing a dual contact member arrangement with a single drive motor.

FIG. **16** is a generalized flow chart of a method for determining a media weight.

FIG. **17** is a flow chart of another method of determining a media weight in an imaging apparatus.

FIG. **18** is a flow chart of a further method of determining a media weight class in an imaging apparatus.

FIGS. **19**A-**19**B illustrate a flow chart of another method of determining a media weight class in an imaging apparatus.

FIGS. **20**A-**20**B illustrate a flow chart of a still further method of determining a media weight class in an imaging apparatus.

DETAILED DESCRIPTION

It is to be understood that the present disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the drawings. The present disclosure is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. As used herein, the terms "having", "containing", "including", "comprising", and the like are open-ended terms that indicate the presence of stated elements or features, but do not preclude additional elements or features. The articles "a", "an", and "the" are intended to include the plural as well as the singular, unless the context clearly indicates otherwise. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

Unless limited otherwise, the terms "connected," "coupled," and "mounted," and variations thereof herein are used broadly and encompass direct and indirect connections, couplings, and mountings. In addition, the terms "connected" and "coupled" and variations thereof are not restricted to physical or mechanical connections or couplings. Spatially relative terms such as "top", "bottom", "front", "back", "rear", "side", "under", "below", "lower", "over", "upper", and the like, are used for ease of description to explain the positioning of one element relative to a second element. These terms are intended to encompass different orientations of the device in addition to different orientations than those depicted in the figures. Further, terms such as "first", "second", and the like, are also used to describe various elements, regions, sections, etc. and are also not intended to be limiting. Like terms refer to like elements throughout the description.

In addition, it should be understood that embodiments of the present disclosure include both hardware and electronic components or modules that, for purposes of discussion, may be illustrated and described as if the majority of the components were implemented solely in hardware. However, one of ordinary skill in the art, and based on a reading of this detailed description, would recognize that, in at least one embodiment, the electronic-based aspects of the invention may be implemented in software. As such, it should be noted that a plurality of hardware and software-based devices, as well as a plurality of different structural components may be utilized to implement the invention. Furthermore, and as described in subsequent paragraphs, the specific mechanical configurations illustrated in the drawings are intended to exemplify embodiments of the present disclosure and that other alternative mechanical configurations are possible.

It will be further understood that each block of the diagrams, and combinations of blocks in the diagrams, respectively, may be implemented by computer program instructions. These computer program instructions may be loaded onto a general purpose computer, special purpose computer, processor, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data processing apparatus may create means for implementing the functionality of each block or combinations of blocks in the diagrams discussed in detail in the descriptions below. These computer program instructions may also be stored in a non-

transitory, tangible, computer readable storage medium that may direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer readable storage medium may produce an article of manufacture including an instruction means that implements the function specified in the block or blocks. Computer readable storage medium includes, for example, disks, CD-ROMS, flash ROMS, nonvolatile ROM and RAM. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions that execute on the computer or other programmable apparatus implement the functions specified in the block or blocks. Output of the computer program instructions may be displayed in a user interface or computer display of the computer or other programmable apparatus that implements the functions or the computer program instructions.

The term "output" as used herein encompasses output from any printing device such as color and black-and-white copiers, color and black-and-white printers, and multifunction devices that incorporate multiple functions such as scanning, copying, and printing capabilities in one device. Such printing devices may utilize ink jet, dot matrix, dye sublimation, laser, and any other suitable print formats. The term "button" as used herein means any component, whether a physical component or graphic user interface icon, that is engaged to initiate an action or event.

The term "image" as used herein encompasses any printed or electronic form of text, graphics, or a combination thereof. "Media" or "media sheet" refers to a material that receives a printed image or, with a document to be scanned, a material containing a printed image. The media is said to move along the media path and the media path extensions from an upstream location to a downstream location as it moves from the media trays to the output area of the imaging device. For a top feed option tray, the top of the option tray is downstream from the bottom of the option tray. Conversely, for a bottom feed option tray the top of the option tray is upstream from the bottom of the option tray. As used herein, the leading edge of the media is that edge which first enters the media path and the trailing edge of the media is that edge that last enters the media path. Depending on the orientation of the media in a media tray, the leading/trailing edges may be the short edge of the media or the long edge of the media, in that most media is rectangular. As used herein, the term "media width" refers to the dimension of the media that is transverse to the direction of the media path. The term "media length" refers to the dimension of the media that is aligned to the direction of the media path. "Media process direction" describes the movement of media within the imaging system as is generally meant to be from an input toward an output of the imaging system **1**. Further relative positional terms may be used herein. For example, "superior" means that an element is above another element. Conversely "inferior" means that an element is below or beneath another element.

Media is conveyed using pairs of aligned rolls forming feed nips. The term "nip" is used in the conventional sense to refer to the opening formed between two rolls that are located at about the same point in the media path. The rolls forming the nip may be separated apart, be tangent to each other, or form an interference fit with one another. With this nip type, the axes of the rolls are parallel to one another and are typically, but do not have to be, transverse to the media path. For example, a deskewing nip may be at an acute angle to the media feed path. The term "separated nip" refers to a nip formed between two rolls that are located at different points along the media path and have no common point of tangency with the media path. Again the axes of rotation of the rolls having a separated nip are parallel but are offset from one another along the media path. Nip gap refers to the space between two rolls. Nip gaps may be positive, where there is an opening between the two rolls, zero where the two rolls are tangentially touching or negative where there is an interference fit between the two rolls.

As used herein, the term "communication link" is used to generally refer to a structure that facilitates electronic communication between multiple components. While several communication links are shown, it is understood that a single communication link may serve the same functions as the multiple communication links that are illustrated. Accordingly, a communication link may be a direct electrical wired connection, a direct wireless connection (e.g., infrared or r.f.), or a network connection (wired or wireless), such as for example, an Ethernet local area network (LAN) or a wireless networking standard, such as IEEE 802.11. Devices interconnected by a communication link may use a standard communication protocol, such as for example, universal serial bus (USB), Ethernet or IEEE 802.xx, or other communication protocols.

Referring now to the drawings and particularly to FIG. **1**, there is shown a diagrammatic depiction of an imaging system **1**. As shown, imaging system **1** may include an imaging device **2**, and an optional computer **50** attached to the imaging device **2**. Imaging system **1** may be, for example, a customer imaging system, or alternatively, a development tool used in imaging apparatus design. Imaging device **2** is shown as a multifunction machine that includes a controller **3**, a print engine **4**, a scanner system **6**, a user interface **7**, a finisher **8** and/or one or more option assemblies **9**.

Controller **3** includes a processor unit and associated memory **10**, and may be formed as one or more Application Specific Integrated Circuits (ASICs). Memory **10** may be any volatile or non-volatile memory or combination thereof such as, for example, random access memory (RAM), read only memory (ROM), flash memory and/or non-volatile RAM (NVRAM). Alternatively, memory **10** may be in the form of a separate electronic memory (e.g., RAM, ROM, and/or NVRAM), a hard drive, a CD or DVD drive, or any memory device convenient for use with controller **3**. Scanner system **6** may employ scanning technology as is known in the art including for example, CCD scanners, optical reduction scanners or combinations of these and other scanner types. Finisher **8** may include a stapler **11**, a punch **12**, one or more media sensors **13**, various media reference and alignment surfaces and an output area **14** for holding finished media. Imaging device **2** may also be configured to be a printer without scanning.

In FIG. **1**, controller **3** is illustrated as being communicatively coupled with computer **50** via communication link **41**. Controller **3** is illustrated as being communicatively coupled with print engine **4**, scanner system **6**, user interface **7**, and finisher **8**, including stapler **11**, punch **12** and sensors **13**, via communication links **42**, **43**, **44**, **45**, respectively. Computer **50** includes in its memory **51** a software program including program instructions that function as an imaging driver **52**, e.g., printer/scanner driver software, for imaging device **2**. Imaging driver **52** is in communication with controller **3** of imaging device **2** via communication link **41**. Imaging driver **52** facilitates communication between imaging device **2** and computer **50**. One aspect of imaging driver **52** may be, for example, to provide formatted print data to imaging device **2**, and more particularly to print engine **4**, to print an image.

Another aspect of imaging driver **52** may be, for example, to facilitate collection of scanned data from scanner system **6**.

In some circumstances, it may be desirable to operate imaging device **2** in a standalone mode. In the standalone mode, imaging device **2** is capable of functioning without computer **50**. Accordingly, all or a portion of imaging driver **52**, or a similar driver, may be located in controller **3** of imaging device **2** so as to accommodate printing and/or scanning functionality when operating in the standalone mode.

Print engine **4**, scanner system **6**, user interface **7** and finisher **8** may include firmware maintained in memory **10** which may be performed by controller **3** or another processing element. Controller **3** may be, for example, a combined printer, scanner and finisher controller. Controller **3** serves to process print data and to operate print engine **4** and toner cartridge **81** during printing, as well as to operate scanner system **6** and process data obtained via scanner system **6** for printing or transfer to computer **50**. Controller **3** may provide to computer **50** and/or to user interface **7** status indications and messages regarding the media, including scanned media and media to be printed, imaging device **2** itself or any of its subsystems, consumables status, etc. Computer **50** may provide operating commands to imaging device **2**. Computer **50** may be located nearby imaging device **2** or be remotely connected to imaging device **2** via an internal or external computer network. Imaging device **2** may also be communicatively coupled to other imaging devices.

Scanner system **6** is illustrated as having an automatic document feeder (ADF) **60** having a media input tray **61** and a media output area **63**. Two scan bars **66** may be provided—in ADF **60** and the other in the base **65**—to allow for scanning both surfaces of the media sheet as it is fed from input tray **61** along scan path SP to output area **63**.

Print engine **4** is illustrated as including laser scan unit (LSU) **80**, a toner cartridge **81**, an imaging unit **82**, and a fuser **83**, all mounted within imaging device **2**. Imaging unit **82** and toner cartridge **81** are supported in their operating positions so that toner cartridge **81** is operatively mated to imaging unit **82** while minimizing any unbalanced loading forces by the toner cartridge **81** on imaging unit **82**. Imaging unit **82** is removably mounted within imaging device **2** and includes a developer unit **85** that houses a toner sump and a toner delivery system. The toner delivery system includes a toner adder roll that provides toner from the toner sump to a developer roll. A doctor blade provides a metered uniform layer of toner on the surface of the developer roll. Imaging unit **82** also includes a cleaner unit **84** that houses a photoconductive drum and a waste toner removal system. Toner cartridge **81** is also removably mounted in imaging device **2** in a mating relationship with developer unit **85** of imaging unit **82**. An exit port on toner cartridge **81** communicates with an entrance port on developer unit **85** allowing toner to be periodically transferred from toner cartridge **81** to resupply the toner sump in developer unit **85**. Both imaging unit **82** and toner cartridge **81** may be replaceable items for imaging device **2**. Imaging unit **82** and toner cartridge **81** may each have a memory device **86** mounted thereon for providing component authentication and information such as type of unit, capacity, toner type, toner loading, pages printed, etc. Memory device **86** is illustrated as being operatively coupled to controller **3** via communication link **42**.

The electrophotographic imaging process is well known in the art and, therefore, will be briefly described. During an imaging operation, laser scan unit **80** creates a latent image by discharging portions of the charged surface of photoconductive drum in cleaner unit **84**. Toner is transferred from the toner sump in developer unit **85** to the latent image on the photoconductive drum by the developer roll to create a toned image. The toned image is then transferred either directly to a media sheet received in imaging unit **82** from one of media input trays **17** or to an intermediate transfer member and then to a media sheet. Next, the toned image is fused to the media sheet in fuser **83** and sent to an output location **38**, finisher **8** or a duplexer **30**. One or more gates **39**, illustrated as being in operable communication with controller **3** via communication link **42**, are used to direct the media sheet to output location **38**, finisher **8** or duplexer **30**. Toner remnants are removed from the photoconductive drum by the waste toner removal system housed within cleaner unit **84**. As toner is depleted from developer unit **85**, toner is transferred from toner cartridge **81** into developer unit **85**. Controller **3** provides for the coordination of these activities including media movement occurring during the imaging process.

While print engine **4** is illustrated as being an electrophotographic printer, those skilled in the art will recognize that print engine **4** may be, for example, an ink jet printer and one or more ink cartridges or ink tanks or a thermal transfer printer; other printer mechanisms and associated image forming material.

Controller **3** also communicates with a controller **15**, via communication link **46**, provided within each option assembly **9** that is provided in imaging device **2**. Controller **15** operates various motors housed within option assembly **9** that position media for feeding, feed media from media path branches PB into media path P or media path extensions PX as well as feed media along media path extensions PX. Controllers **3**, **15** control the feeding of media along media path P and control the travel of media along media path P and media path extensions PX.

Imaging device **2** and option assembly **9** each also include a media feed system **16** having a removable media input tray **17** for holding media M to be printed or scanned, and a pick mechanism **18**, a drive mechanism **19** positioned adjacent removable media input trays **17**. Each media tray **17** also has a media dam assembly **20** and a feed roll assembly **21**. In imaging device **2**, pick mechanism **18** is mechanically coupled to drive mechanism **19** that is controlled by controller **3** via communication link **46**. In option assembly **9**, pick mechanism **18** is mechanically coupled to drive mechanism **19** that is controlled by controller **3** via controller **15** and communication link **46**. In both imaging device **2** and option assembly **9**, pick mechanisms **18** are illustrated in a position to drive a topmost media sheet from the media stack M into media dam **20** which directs the picked sheet into media path P or extension PX. Bottom fed media trays may also be used. As is known, media dam **20** may or may not contain one or more separator rolls and/or separator strips used to prevent shingled feeding of media from media stack M. Feed roll assemblies **21**, comprised of two opposed rolls feed media from an inferior unit to a superior unit via a slot provided therein.

In imaging device **2**, a media path P (shown in dashed line) is provided from removable media input tray **17** extending through print engine **4** to output area **38**, or when needed to finisher **8** or to duplexer **30**. Media path P may also have extensions PX and/or branches PB (shown in dotted line) from or to other removable media input trays as described herein such as that shown in option assembly **9**. Media path P may include a multipurpose input tray **22** provided on housing **23** of imaging device **2** or incorporated into removable media tray **17** provided in housing **23** and corresponding path branch PB that merges with the media path P within imaging device **2**. Along media path P and its extensions PX are provided media position sensors **24**, **25-1**, **25-2** which are

used to detect the position of the media, usually the leading and trailing edges of the media, as it moves along the media path P or path extension PX. Media position sensor **24** is located adjacent to the point at which media is picked from each of media trays **17** while media position sensors **25-1**, **25-2** are positioned further downstream from their respective media tray **17** along media path P or path extension PX. Media position sensor **25-1** also accommodates media fed along path branch PB from multipurpose media tray **22** and is illustrated at a position downstream of feed roll pair **121**. Media position sensor **25-2** is illustrated at a position on path extension PX downstream of media tray **17** in option assembly **9**. Additional media position sensors may be located throughout media path P and a duplex path, when provided, and their positioning is a matter of design choice. Media position sensors **24**, **25-1**, **25-2** may be an optical interrupter or a limit switch or other type of edge detector as is known to a person of skill in the art and detect the leading and trailing edges of each sheet of media as it travels along the media path P, path branch PB or path extension PX.

Media type sensors **27** are provided in imaging device **2** and each option assembly **9** to sense the type of media being fed from removable media input trays **17**. Media type sensor **27** may include a light source, such as an LED and two photoreceptors. One photoreceptor is aligned with the angle of reflection of the light rays from the LED to receive specular light reflected from the surface of the sheet of media and produces an output signal related to amount of specular light reflected. The other photoreceptor is positioned off of the angle of reflection to receive diffuse light reflected from the surface of the media and produces an output related to the amount of diffused light received. Controller **3**, by ratioing the output signals of the two photoreceptors at each media type sensor **27**, can determine the type of media in the respective media tray **17**.

Media size sensors **28** are provided in image forming device **2** and each option assembly **9** to sense the size of media being feed from removable media input trays **17**. To determine media sizes such as Letter, A4, A6, Legal, etc., media size sensors **28** detect the location of adjustable trailing edge media supports and one or both adjustable media side edge media supports provided within removable media input trays **17** as is known in the art. Sensors **24**, **25-1**, **25-2**, **27**, and **28** are shown in communication with controller **3** via communication link **47**.

Also shown on media path P upstream of and adjacent to media position sensor **25-1** is media feed roll pair **121** driven by a drive mechanism **122**. Positioned downstream of media feed roll pair **121** is a media stiffness sensor assembly **200**. Drive mechanism **122** and media stiffness sensor assembly **200** are in communication with controller **3** via communication link **47**. Sensor assembly **200** may also be located upstream of feed roll pair **121**.

Referring to FIG. **2**, the structure and operation of media stiffness sensor **200** within imaging device **2** will be described. In FIG. **2**, drive mechanism **122** is illustrated as being operatively coupled to feed roll **121-1** while feed roll **121-2** is an idler roll. Feed roll pair **121** forms feed nip **123**. Media stiffness sensor assembly **200** is illustrated at a position downstream of feed nip **123** a predetermined length L_1. Media position sensor **25-1** is illustrated at a position downstream of media stiffness sensor assembly **200** a predetermined length L_{BP} from feed nip **123** that is greater than length L_1. An additional sensor assembly is also illustrated, media stiffness sensor assembly **300**, at a position between sensor assembly **200** and feed nip **123** a predetermined length L_2. Because both sensor assemblies **200**, **300** are similar, discussion of the construction and operation of only sensor assembly **200** will be described with noted exceptions where the construction or operation of sensor assembly **300** may differ.

Media sheet M, having leading and trailing edges LE, TE, is shown having being fed from one of media input trays **17** and through feed nip **123**. The leading edge LE of media sheet M is shown as having actuated media position sensor **25-1**. The leading edge LE of media sheet M is illustrated as being downstream of media stiffness sensor assembly **200**. Print engine **4** is downstream of feed nip **123** and in operative communication with controller **3** via communication link **42**.

Media stiffness sensor assembly **200** comprises a translation mechanism **210** that is operatively coupled to a drive mechanism **220** including a DC motor **221**. A contact member **230** is coupled to translation mechanism **210**. A position sensor **240** is operatively coupled to provide the position of translation mechanism **210**. Media stiffness sensor assembly **300** includes a translation mechanism **310**, a drive mechanism **320** with motor **321**, a contact member **330** coupled to translation mechanism **310** and a position sensor **340**.

Drive mechanisms **220**, **320** are in operative communication with controller **3** via communication links **47-1**, **47-2**, respectively, and position sensors **240**, **340** via communication link **47-4**. Drive mechanism **122** is in operative communication with controller **3** via communication link **47-3** while media position sensor **25-1** is in operative communication with controller **3** via communication link **47-5**. A motor driver **306** may also be provided in controller **3** to energize motors used in drive mechanisms **122**, **220** and **320**. As shown motor drivers **306-1**, **306-2** and **306-3** respectively drive motors **221**, **321** and **122-1** in drive mechanisms **220**, **320** and **122**. Motor driver **306** may also be configured to measure the current being used by the motors in the drive mechanisms and to provide a pulse width modulated drive signal.

When driven by drive mechanism **220**, translation mechanism **210** moves contact member **230** between a home position **231** through a travel distance indicated at **232**, indicated by an empty circle. Position sensor **240** determines when contact member **230** is at the home position **231** thereof and when at the travel distance **232**. Position sensor **240** may be a rotary encoder, such as rotary encoder **240**A shown in FIG. **2**A that provides a signal indicative of the position of contact member **230**. Rotary encoder **240**A may further be a quadrature-type encoder that provides a signal representative of both distance and direction. Rotary encoder **240**A may be operatively connected to drive mechanism **220** or to translation mechanism **210** via a gear train. In a further form, position sensor **240** may be implemented as shown in FIG. **2**B where position sensor **240**B comprises a flag **241**A affixed to translation mechanism **210**A and a pair of spaced apart position sensors **241**B, **241**C indicating the home position and travel distance of contact member **230**A. Translation mechanism **210**A is shown being driven by drive mechanism **220**A and is illustrated in a position between the home position **231** and the travel distance **232**. Position sensors **241**B, **241**C operate in a manner similar to that of position sensors **24**, **25-1**, **25-2** previously described. The type of position sensor used to implement position sensor **220** is a matter of design choice and should not be considered to be a limitation of media stiffness sensor assembly **200**.

It will be appreciated that media stiffness sensor assemblies may also be located upstream of feed nip **123** at a position between feed nip **123** and the trailing edge TE of media sheet M as indicated by dashed blocks **200**A and **300**A which correspond to media stiffness sensor assemblies **200**, **300** respectively, and operate in substantially similar fashion except that the trailing portion of media sheet M is used in the

stiffness measurement. A trailing edge position sensor, such as sensor **25-1**A shown in a dashed circle, may be provided to indicate the location of the trailing edge TE or the location of the trailing edge TE of media sheet M may be inferred based on the position of the leading edge LE and the media length information provided by the media size sensors **28**. The media position sensor, its placement with respect to feed nip **123** and the method of determining edge location of media sheet M should not be considered to be a limitation of the present assemblies or methods.

Contact member **230** may have several configurations and cross-sectional shapes. In FIG. **3**A contact member **230**A is shown as being a bar shown extending partially across the media path width W_P and is in a slightly offset position with respect to the width of media path P that is indicated by the set of dashed parallel lines. In FIG. **3**A contact member **230**A has a length L1 that can be greater than media path width W_P but due to it being offset extends across only a portion of media path width W_P. As shown there, contact member **230**A has a generally C-shaped form. In FIG. **3**B contact member **230**B is again shown in a bar configuration that has a length L2 that is greater than the media path width W_P and has a generally T-shaped form. In FIG. **3**C, contact member **230**C, again shown as a bar, is configured in an L-shape with a leg thereof having a length L3 that extends partially across the media path width W_P, contact member **230**C may be positioned within the media path width W_P or offset as shown for contact member **230**A. The length of contact member **230** when configured as a bar may be chosen such that it will span the majority of each width of each of the various media types that may be provided in media input trays **17** and fed through feed roll pair **121**, however, shorter and longer lengths may be used than those illustrated. Contact members shown in FIGS. **3**A-**3**C may also be referred to as line contacts or line contact members. FIG. **3**D illustrates a further configuration of contact member **230** termed a point contact. There contact member **230**D is a rod, a free end of which is moved into contact with media sheet M.

Shown in FIGS. **4**A-**4**C are configurations for the contact face of contact member **230**. The contact face **235** is that portion of the contact member **230** that is moved into media sheet M to apply a bending force thereto. In either the line-type or point-type configuration for contact member **230**, contact face **235**, may be pointed, rounded, or flat as shown in FIGS. **4**A-**4**C, respectively.

The positioning of contact member **230** with respect to the plane of the media sheet is not limiting. Contact member **230** only needs to be positioned with respect the media path P or the plane of the media sheet (which is into the plane of the page in FIG. **2**) such that when it is moved into contact with media sheet M, contact member **230** provides a force component F_n that is normal to the surface of the media sheet M sufficient to bend media sheet M. Movement of the contact member **230** so that it provides a force component F_n that is normal to the surface of the media sheet M sufficient to bend media sheet M is meant to be encompassed by the terms "translation", "translates" and "translating" and variants thereof as used in this specification. In other words, contact member **230** may approach at an angle with respect to the plane of the media sheet M. This is illustrated in FIGS. **5**A-**5**B. In FIG. **5**A contact member **230** is illustrated as approaching along the X-axis into the plane of the media sheet which lies along the Y-axis at three different acute approach angles, one being perpendicular and the outer two illustrated at opposite acute angles with respect to media sheet M. Of course other acute angles may be used. In FIG. **5**B, contact member **230** is illustrated as approaching along the X-axis into the plane of the media sheet which lies along the Z-axis at three different acute approach angles, the center one being perpendicular and the outer two shown at opposite acute angles with respect to media sheet M. Again other acute angles may be used.

FIG. **6** illustrates operative contact regions, indicated by the grayed bars LC for line contacts and circles PC for point contacts, between contact member **230** and the plane of the media sheet M. It should be noted that the contact regions occur in cantilevered portions of the media sheet. The dashed rectangle NL illustrates possible locations of nip lines for forming the cantilevered portions of the media sheet M. The line contact regions LC may extend across the width of the media sheet M near the leading and trailing edges LE, TE, along either of the side edges SE, across the corner areas of media sheet M and at various points about the periphery of media sheet M. The locations shown for point contact areas PC circles are illustrative only and not meant to limit point contacts to only the illustrated areas. It will appreciated that the contact regions, LC, PC would be positioned with respect to an edge of the media sheet M such that the media edge will not slip past the contact member when the contact member is at the travel distance.

FIGS. **7**A-**7**C illustrate a measurement cycle for stiffness sensor assembly **200**. Media process direction is indicated by arrow A. In FIG. **7**A, the leading edge LE of media sheet M has been detected by position sensor **25-1** (not shown for purposes of clarity) and media sheet M is staged for measurement. A portion of media sheet M is cantilevered from feed nip **123** of feed roll pair **121** forming a beam portion BP having length L_{BP}. It will be appreciated that the cantilever portion BP of media sheet M may be formed by devices other than feed roll pair **121**. For example, clamping bars may be provided along the media path P to hold media sheet M so that a portion thereof is cantilevered. Also a cantilever portion of media sheet may also be formed along a side edge as indicated by the contact regions shown in FIG. **6**.

Contact member **230** is in its home position **231** and positioned intermediate the leading edge LE and feed nip **123** at a length L_1. In one form, length L_1 is in the range of about 5 mm to about 50 mm and length L_{BP} is in a corresponding range of about 10 mm to about 100 mm. In FIG. **7**B, contact face **235** of contact member **230** has been moved into the plane of media sheet M (which as illustrated is perpendicular to the plane of the page), has reached the travel distance **232** and has deflected or bent beam portion BP of media sheet M. At the travel distance **232**, the deflected portion BP of media sheet M has stored energy. The deflected portion BP of media sheet M may be modeled as a cantilevered beam of a length L_1 with contact member **230** applying a force thereto to create a bending moment. The amount of travel energy used by stiffness sensor assembly **200** to reach the travel distance **232** and to bend the portion of media sheet M of length L_1 is determined. This energy amount may be correlated to the stiffness or thickness of media sheet M.

In FIG. **7**C, contact member **230** has been retracted to its home position **231** with beam portion BP releasing its stored energy back into contact member **230** as it unbends. The amount of return energy used by stiffness sensor assembly **200** to return to its home position **231** is determined. The media sheet M is then fed in the media process direction indicated by arrow A. The energy provided by beam portion BP helps in returning contact member **230** to its home position **231**. In another embodiment the difference between the travel energy and return energy may be correlated to media

thickness or stiffness. For example, the difference between the travel energy and the return energy is used to determine a weight of the media sheet M.

Referring back to FIG. **2**, contact member **330** is in its home position **331** and positioned intermediate contact member **230** and feed nip **123** at a length L_2 from feed nip **123** that is less than length L_1. In one form length L_2 is in the range of about 2 mm to about 15 mm By providing a shorter measurement length on the portion BP of the media undergoing bending, stiffness measurements of lighter weight media made by media stiffness sensor assembly **300** are more separable than would be possible with the longer measurement length present when using sensor assembly **200** to make the measurements.

Referring to the data illustrated FIGS. **8-9**, the data in FIG. **8** was obtained using the length L_1 of sensor assembly **200** while that in FIG. **9** was obtained using the shorter length L_2 of sensor assembly **300**, both assemblies **200**, **300** being configured as shown in FIG. **14**. Common media types were tested having basis weights ranging in a continuum from about 45 grams/meter^2 to about 500 grams/meter^2, or, using another metric, having thicknesses ranging in a continuum from about 2 mils to about 12 mils. Sixteen various media types were tested. Media samples 1-16 are, respectively: business envelopes; sixteen pound paper; twenty-four pound cotton paper; twenty-eight pound glossy paper; sixteen pound recycled paper; twenty-four pound smooth paper; seven mil synthetic media; paper labels; sub-sixteen pound office paper; ninety pound cardstock; twenty-four pound bond paper; twenty pound office paper; transparency media; vinyl labels; sixty pound cardstock; and thirty-two pound office paper. The motor power which correlates to media stiffness is shown for these sixteen different types of media. As shown for media samples 1, 7, 8, 10, and 15, the range of their motor power values is significantly larger than the range of motor power values for the remaining media samples. The higher motor power values correlate to these media types having a greater stiffness than the other samples. This allows these five media types to be more easily discerned from one another. However, the range in motor power values between media samples 2-6, 9 and 11-14 and 16 is significantly less than the range of motor power values for media samples 1, 7, 8, 10 and 15, and, at the scale used in FIG. **15**, are harder to discern from one another. By using sensor assembly **300** where the shorter length L_2 is used, the scale for the range of motor power has been expanded between the values of 0 and 0.5 so that, as shown in FIG. **9**, the differences between samples 2-6, 9, and 11-14 and 16 may be more readily detected. FIGS. **8-9** also illustrate three possible media weight classes, class 1 being media requiring having a motor power value higher than 1.0, class 2 being media requiring a motor power value between 0.5 and 1.0 and class 3 being media requiring a motor power between 0 and 0.5. The classes and the range of values within each class may be stored in a look-up table **10-1** in memory **10** (see FIG. **2**).

Referring now to FIGS. **10-12**, the operating principles of the stiffness sensor assembly **200** will be described. Where the operation of stiffness sensor assembly **300** differs from that of sensor assembly **200** it will be noted. As previously described drive mechanism **200** contains a brushed DC motor **221** with an attached quadrature encoder **240** used to measure absolute angular position and speed. As is known in the art, motor driver **306**, which may be an H-bridge motor driver, is used to energize motor **221**. Motor driver **306** also measures the electrical current in the motor during a Pulse Width Modulated (PWM) on-time.

Shown in FIG. **10** is a block diagram of one form of a closed loop control system **500** that may be used to control the position of motor **221**. The position and speed measured from the encoder **240** and motor current may be both used as feedback signals in control system **500**, this is indicated by the signal y representing these three feedback signals which are outputted from plant **502**. The signal y may be comprised of one of motor current I; motor current I and motor speed ω; motor current I and motor position θ; and motor current I, motor speed ω and motor position θ. The plant **502** represents the mathematical model of the motor **221** where u is the applied voltage, W is an unknown torque applied to the motor shaft and signal y is the output. The observer **504** in a feedback loop around plant **502** has the applied voltage u, and signal y as inputs and generates filtered estimated signals of the motor states—position, speed and current—which are collectively represented by signal x-hat that is fed back to node **506** through K which is a matrix of feedback gains for each of the respective estimated signals. The signal r is the commanded position for motor **221** which in turn positions contact member **230**. Signal r may vary with time and is fed to node **512** and to feed-forward gain N the output of which is provided to node **506**. Node **512** also receives as input the angular position signal θ. The angular position signal θ is extracted from signal y using matrix multiplier MM that is outputted from plant **502** and fed to multiplier MM to remove motor current and motor speed signals if present in signal y. The output of node **512** is the position error of the mechanism (r minus θ), designated as signal u_a, and, is the input to additional dynamics **510**. Additional dynamics **510** contains a mathematical model of the commanded position signal, r, such that the steady-state position error of the control system will asymptotically approach zero and provides an output signal y_a to node **506**. The output of node **506** is the applied voltage signal u. The control algorithm may be executed at a rate of 1 kHz.

The commanded position profile is pi radians of a sine wave. The additional dynamics **510** may be designed such that the control system **500** can track a sine wave of known frequency with zero steady-state error, or simply track a step input. Although the sine-tracking dynamics yielded the smallest error, both designs yield sufficiently small steady-state error. The step-tracking dynamics were found to yield higher stability margins.

The metric used to estimate bending stiffness of the media sheet M was derived from the electrical energy input to the motor **221**. The voltage (which is calculated based on the PWM duty cycle) and the current (which is measured) are multiplied together to yield an estimate of the instantaneous power input to the motor **221** every time the control algorithm executes (every millisecond). This power value is integrated to produce an estimate of the total energy input to the motor **221**.

FIG. **11** represents the energy balance as the contact member **230** is extended. During the first half of a measurement cycle when contact member is translated into media sheet M and through travel distance and media sheet M is deflected, energy from the driver **306**, block **550**, is delivered into the motor **221** and either generates mechanical energy or motion to deflect media sheet M, block **560**, or is wasted through mechanical and electrical losses, block **570**. The energy that generates motion to deflect media sheet M ultimately is stored as potential energy in the media sheet M, which is a function of the page stiffness.

FIG. **12** represents the energy balance when contact member **230** is retracted to its home position **231**. During retraction, energy from the driver **306**, block **650** is delivered to the

motor **221** and generates motion to retract the contact member **230**. All of this energy is unrecoverable and goes towards mechanical and electrical losses, block **670**. The potential energy that was stored in the deflect media sheet M, block **660**, is now delivered back to the motor **221** as mechanical energy. As a result, the energy input required from the driver **306** will be less than it was when deflecting the media sheet M. Specifically, the energy stored in the deflect media sheet M will work to reduce the overall load on the motor **221**, which will require less current to be drawn from the driver **306**, which also results in fewer electrical losses. At some points during the retraction it is even possible for energy to be delivered back to the driver **306**.

The total electrical energy input E_{in} to the motor **221** over the entire measurement cycle can be expressed as set forth in Equation 1:

$$E_{in}=2U+W_{loss,e}+W_{loss,r}+E_{loss,e}+E_{loss,r} \quad \text{Eq. 1}$$

where U is the potential energy stored in the deflected page, $W_{loss,e}$ and $W_{loss,r}$ $E_{loss,e}$ are the mechanical losses during the extension (e) and retraction (r) of contact member **230**, respectively, and $E_{loss,e}$ and $E_{loss,r}$ are the electrical losses during the extension and retraction of contact member **230**, respectively. The electrical energy difference between engaging and retracting the mechanism can be expressed as set forth in Equation 2:

$$\Delta E_{in}=2U+\Delta E_{loss}+\Delta W_{loss} \quad \text{Eq. 2}$$

where ΔE_{in} is the change of energy input ΔE_{loss} and ΔW_{loss} are the changes in electrical and mechanical losses during the measurement cycle. Either E_{in} or ΔE_{in} may be used as the metric to correlate to media stiffness. However, ΔE_{in} metric has more linear relationship to the media stiffness, as seen in the simulation data shown in FIG. **13** where the solid straight line **700** represents the approximately linear relationship between ΔE_{in} and media stiffness and the dashed curved line **710** represents the non-linear relationship between E_{in} and media stiffness.

Referring now FIG. **14**, a more detailed illustration of media stiffness assembly **200** is illustrated. As both media stiffness assemblies **200**, **300** are substantially the same except for their position in relation to the location of feed nip **123** only stiffness assembly **200** will be described. Frame **201** of sensor assembly **200** is mounted within imaging device **2** transverse to media path P, indicated by the wide arrow in FIG. **14** and consequently transverse to media sheet M shown in phantom line. Frame **201** includes a base **202** on which are mounted spaced apart, opposed legs **203-1**, **203-2**, that are illustrated as extending vertically upward. Translation mechanism **210** and drive mechanism **220** are mounted to frame **201**. Translation mechanism **210** comprises a translation member, illustrated as first and second translation members **211-1**, **211-2** that are substantially the same in structure. Provided on each translation member is a rack portion and guide slot, shown as rack portion **212-1** and guide slot **213-1** on translation member **211-1** and rack portion **212-2** and guide slot **213-2** on translation member **211-2** which are obscured by leg **203-2** on frame **201**. A pair of guide pins is mounted to each leg, shown as pairs **205-1** and **205-2** mounted to legs **203-1** and **203-2**, respectively, and is received into respective guide slots **213-1**, **213-2**. Guide pins **205-1**, **205-2** guide and support translation members **211-1**, **211-2** during translation. Adjacent first ends **214-1**, **214-2** of translations members **211-1**, **211-2**, respectively, are aligned openings **215-1**, **215-2** which receive respective ends **231-1**, **231-2** of contact member **230**, which here is illustrated as being a rod or cylinder. While two translation members **211-1**, **211-2** are illustrated, a single translation member may be used and be operatively coupled to motor **221**.

Mounted on frame **201** is drive mechanism **220** comprising a DC motor **221**, a rack gear **223**, illustrated as being rack gears **223-1**, **223-2**, axle **224**. Rack gears **223-1** and **223-2** are mounted to axle **224** that is rotatably mounted to legs **203-1**, **203-2**. Rack gears **223-1**, **223-2** operatively engage with respective rack portions **212-1**, **212-2** and with motor **221** via a motor drive shaft mounted pinion gear obscured by leg **203-2**. Motor **221** is shown mounted on leg **203-2** but may be mounted on leg **203-1** or mounted elsewhere in imaging device **2**. Drive shaft **222** of motor **221** engages with rack gear **223-2** to provide torque for rotating rack gears **223-1**, **223-2** and axle **224**. Rotation of motor **221** in a first direction translates contact member **230** away from its home position **231** through travel distance **232** and rotation of motor **221** in a second direction opposite the first direction, translates contact member back to its home position **231**. Position sensor **240**, illustrated as being a quadrature encoder **240**, is operatively coupled to drive shaft **222**. Motor **221** and encoder **240** are communicatively coupled to controller **3** via communication links **47-4**, **47-3**, respectively.

FIG. **15** illustrates a further construction of sensor assemblies **200**, **300** that are operated using a single drive mechanism. As shown translation members **211**, **311** of drive assemblies **200**, **300**, respectively are slidably mounted to frame **201** on guide pin pairs **205**, **305**, respectively. Contacts members **230**, **330** are schematically depicted mounted to translation members **211**, **311**, respectively. Translation members **211**, **311** are mounted in a spaced, aligned relationship such that their respective rack portions **212**, **312** are opposed. Mounted therebetween is rack gear **223** that is driven by motor **221**. Rack gear **223** is operably engaged with the rack portions **212**, **312**. Rotation of rack gear **223** in the first direction will translate contact member **230** away from its home position while simultaneously translating contact member **330** toward its home position. Rotating rack gear **223** in the second direction reverses the respective translation directions of contact members **230**, **330**.

While a reversible motor is illustrated being used with drive mechanisms **220**, **320**, drive mechanisms **220**, **320** may also use a single direction motor in combination to move contact members **230**, **330** through travel distances **232**, **332**, respectively, while using a spring attached between each translation mechanism **210**, **310** and frame **201** to return the respective contact members to their respective home positions when the single direction motor is deenergized. As a person of ordinary skill in the art would recognize, the design of the translation mechanism **210** and drive mechanism **220** should not be considered as limiting.

Referring now to FIG. **16** a block diagram of a method M**1** of using the aforementioned media stiffness sensor assemblies for determining a media weight on a media sheet moveable along a media path P in imaging device **2** is illustrated.

Method M**1** begins at start block B**1**. At block B**2**, a media sheet M is positioned along the media path P of an imaging device **2** to form a cantilevered portion. At block B**3**, a moveable first contact member **230** is positioned to be contactable with the cantilevered portion of the media sheet M. At block B**4**, the first contact member is moved using a motor from a home position **231** through a first travel distance to bend the cantilevered portion of media sheet M. At block B**5**, a time varying parameter of the motor is measured during moving of the first contact member **230** through the first travel distance. At block B**6**, based on the measured motor parameter, a media weight is selected from a look up table containing a plurality of motor parameter measurements and corresponding media

weights. At block B7, one or more parameters of imaging device 2 is adjusted based on the selected media weight. At block B8, method M1 ends.

The time varying motor parameters that are measured may be selected from a motor peak current, a motor root mean square current, a travel energy used to move the first contact member through the travel distance, a rate of change of motor current with respect to displacement of the first contact member, a rate of change of motor current with respect to time of movement of the first contact member through the travel distance, a rate of change of motor voltage respect to displacement of the first contact member, and a rate of change of motor voltage with respect to time of movement of the first contact member through the travel distance.

One way of determining the travel energy for the first contact member 230 comprises: providing a motor, such as motor 221 energized by a power supply using a motor driver, such as motor driver 306-1, having pulse width modulation duty cycle, the motor 221 being operatively coupled to the first contact member 230 for translating the first contact member 230 between the home position thereof and the first travel distance. At each time interval of a plurality of predefined time intervals occurring during moving the first contact member 230 from the home position thereof through the first travel distance, a motor current in motor 221 is measured. A motor voltage is determined by calculating a product of the pulse width modulated duty cycle and a motor supply voltage provided via motor driver 306-1; and an instantaneous input power value to the motor 221 is then calculated as the product of the motor current and the motor voltage. Upon the first contact member 230 reaching the first travel distance, the travel energy is calculated by summing the calculated instantaneous input power value for motor 221 determined for each time interval of the plurality of predefined time intervals that occurred while translating the first contact member 230 from the home position thereof through the first travel distance.

The selected operating parameter of imaging device 2 to be adjusted may be one of: a media speed within the print engine 4, a duplex control scheme, a fuser temperature, a transfer voltage, an output location and a finishing process such as stapling or hole punching. The top speeds of a print engine are designed to support common media weights such as twenty pound media. For thicker/heavier media, the controller 3 would slow the media speed to ensure that the media can be picked, fed and fused. A slower media speed increases the residence time in the fuser 83 providing a higher amount of energy needed to fuse toner to the heavier weight media types. The duplex control scheme may be selected based on media weight where the controller 3 may elect not to send a heavier weight media sheet through a duplex path because turn radii in the duplex path may not be optimized for the heavier media weight types. Fusing temperature is dependent on media thickness. The heavier the media, the more energy is needed to ensure proper fusing of toner to it. If the imaging device 2 cannot maintain a fusing temperature due to the available line voltage, controller 3 may increase fuser temperature and/or reduce media speed to ensure proper fusing as media weight increases. The transfer voltage refers to the voltage needed to transfer the toned image onto the media sheet. For heavier media, a higher transfer voltage may be needed. For a given media weight, the controller 3 can either increase the transfer voltage and/or reduce media speed to ensure proper toner transfer to the media. Media weight may also effect the choice of output location and/or finishing options that would be available in that heavier media may not be able to be sent to a given output location due to small radius turns in the media path or that the number of heavier media sheets may need to be limited as compared to lighter weight media sheets when undergoing stapling and hole punching. When finishing lighter weight media, stapling force and/or hole punch force may be decreased.

Referring now to FIG. 17 a block diagram of a method M10 of using the aforementioned media stiffness sensor assemblies for determining a media weight on a media sheet moveable along a media path P in imaging device 2 is illustrated.

Method M10 begins at start block B10. At block B15, a media sheet is fed into feed nip 123. At block B20 a translateable first contact member 230 is positioned at a first distance from the feed nip 123. The first contact member 230 may be operatively coupled to translation mechanism 210 which is operatively coupled to a reversible drive mechanism 220. A position encoder 240 may be operatively coupled to either the drive mechanism 220 or to the translation mechanism 230. Rotating the drive mechanism 220 in a first direction moves the translating mechanism 210 to translate the first contact member 230 from the home position thereof toward the media sheet, and rotating the drive mechanism 220 in a second direction moves the translating mechanism 210 to translate the first contact member 230 to return to the home position thereof. Position encoder 240 provides a signal representative of the position of the first contact member as it moves between the home position thereof through a first travel distance.

At block B25 an edge, as illustrated leading edge LE, of the media sheet M is positioned beyond the position of the first contact member 230 at a second distance from the nip that is greater than the first distance. Next at block B30 the first contact member 230 is translated from a home position thereof through a first travel distance into bending contact with the media sheet M.

At block B35 a travel energy used to translate the first contact member 230 the first travel distance is determined. One way of determining the travel energy for the first contact member 230 comprises: providing a motor, such as motor 221 energized by a power supply using a motor driver, such as motor driver 306-1, having pulse width modulation duty cycle, the motor 221 being operatively coupled to the first contact member 230 for translating the first contact member 230 between the home position thereof and the first travel distance. At each time interval of a plurality of predefined time intervals occurring during translating the first contact member 230 from the home position thereof through the first travel distance, a motor current in motor 221 is measured when translating the first contact member 230 from the home position thereof through the first travel distance. A motor voltage is determined by calculating a product of the pulse width modulated duty cycle and a motor supply voltage provided via motor driver 306-1; and an instantaneous input power value to the motor 221 is then calculated as the product of the motor current and the motor voltage. Upon the first contact member 230 reaching the first travel distance, the travel energy is calculated by summing the calculated instantaneous input power value for motor 221 determined for each time interval of the plurality of predefined time intervals that occurred while translating the first contact member 230 from the home position thereof through the first travel distance.

At block B40 the first contact member 230 is returned to the home position thereof. Next, at block B45, a return energy used to return the first contact member 230 to its home position is determined. The return energy is determined in substantially the same manner as the travel energy was determined. At each time interval of a plurality of predefined time intervals occurring while translating the first contact member 230 through the first travel distance back to its home position,

the motor current for motor **221** is measured when translating the first contact member **230** back to the home position; the motor voltage is calculated by calculating the product of the pulse width modulated duty cycle and a motor supply voltage provided via motor driver **306-1**; an instantaneous input power value to the motor **221** is determined by calculating the product of the motor current and the estimated motor voltage; and, upon the first contact member **230** returning to its home position, the return energy is calculated by summing the calculated instantaneous input power value determined for each time interval of the plurality of predefined time intervals that occurred while translating the first contact member **230** to return to its home position.

At block B**50** an energy difference between the amounts of travel energy and return energy for the first contact member is determined and, at block B**55**, based on the energy difference for the first contact member, a media weight is selected. The selection of the media weight may be done by selecting one media weight class from a plurality of predetermined plurality of media weight classes or selecting one media weight from a predetermined continuum of media weights. Optionally, the total energy used for the travel and return of contact member **230** may also be used. The is shown at optional blocks OB**50** and OB**55**. Proceeding from B**45**, method M**10**, at optional block OB**50**, the travel energy and return energy is summed for the first contact member **230**, and, at optional block OB**50**, based on the energy sum for first contact member **230**, a media weight is selected.

A block B**60**, a print engine **4** is provided downstream of the feed nip and at block B**65** at least one operating parameter of the print engine is adjusted based on the select media weight as previously described. Thereafter, at block B**70** method M**10** ends.

In a further form, method M**10** may be modified to include a second contact member **330** that operates in a similar fashion to the first contact member **230**. Operation of the second contact member **330** is described with respect to FIG. **18**. The use of the second contact member **330** occurs after block B**25** at point A of FIG. **17** where method M**10** transitions to FIG. **18**. At block B**100**, translateable second contact member **330** is positioned to contact the cantilevered portion of the media sheet intermediate the feed nip **123** and the point at which the first contact member **230** would contact the cantilevered portion. Next, at block B**105**, second contact member **330** is translated from its home position along a second travel distance toward the media sheet M. The second travel distance may be the same as, longer than, or shorter than the first travel distance. At block B**110**, a travel energy used to translate the second contact member **330** the second travel distance is determined. Simultaneously therewith at block B**115**, a determination is made as to whether or not the travel energy being used during translating the second contact member **330** along the second travel distance exceeds a threshold value.

On determining that the threshold value has not been exceeded, method M**10** proceeds to block B**120** where the second contact member **330** is returned to its home position and, thereafter, at block B**125**, a return energy used to return second contact member to the home position is determined. At block B**130**, method M**10** determines an energy difference between the amounts of travel energy and return energy for the second contact member **330** and then at block B**135** selects, based on the energy difference for the second contact member **330**, a media weight. Thereafter, method M**10** returns at point B to block B**60**.

Referring back to block B**115** when it is determined that the threshold value has been exceeded, method M**10** proceeds to block B**140** where the second contact member **330** is returned to its home position and the method M**10** then proceeds back to block B**30** at point A to cycle first contact member **230** through a measurement cycle.

A second motor **321** energized by a second motor driver **306-2** having a pulse width modulation duty cycle may be used to translate the second contact member **330** and the travel energy and return energy of the second contact member **330** is determined in the same manner as previously described for first contact member **230** and will not be repeated.

On determining that the threshold value has been exceeded, the acts of: translating the first contact member **230** from the home position thereof through first travel distance; determining an amount of travel energy used to translate the first contact member **230**; returning first contact member **230** to the home position thereof, determining the amount of return energy for the first contact member **230**, determining the energy difference between the amounts of travel energy and return energy for the first contact member **230**, and, selecting, based on the energy difference for the first contact member **230**, a media class are performed.

Referring to FIGS. **19**A-**19**B, a further method M**20** for determining a media weight is illustrated for imaging device **2** using a print engine **4** to form an image on a media sheet moveable along a media path therein. Method M**20** comprises:

feeding, at block B**200**, a media sheet into a nip formed between a pair of feed rolls positioned along the media path upstream to the print engine;

positioning, at block B**205**, an edge of the media sheet at a first distance from the nip;

positioning, at block B**210**, a translateable first contact member **230** intermediate the nip and the edge of the media sheet at a second distance from the nip that is less than the first distance;

determining, at block B**215**, whether or not the edge of the media sheet is in position; when it is determined that the edge of the media sheet is not in position, adjusting, at block B**217** the position of the media sheet until it is in position, this may be accomplished rotating the feed roll pair **121** in either the forward (downstream) or reverse (upstream) direction;

when it is determined that the edge of the media sheet is in position:

then, at block B**220**, translating along a travel distance, using a reversible motor **221**, the first contact member **230** from a home position thereof into contact with the media sheet in a direction transverse to a media plane P of the media sheet;

determining, at block B**225**, whether or not the first contact member **230** has translated the travel distance;

when it is determined that the first contact member **230** has not translated the travel distance, then determining, at block B**230**, whether or not a motor current maximum threshold has been exceeded by motor **221**;

when it is determined that the motor current maximum threshold has been exceeded, selecting, at block B**235** a heaviest media weight class from a predetermined group of media weight classes and reversing the motor **221** and returning the first contact member **230** to the home position thereof; and

when it is determined that the motor current maximum threshold has not been exceeded:

continuing, at block B**240**, translating first contact member **230** to the travel distance;

determining, at block B**245**, a travel energy used for the first contact member **230** to reach the travel distance;

reversing the motor **221** and returning the first contact member **230** to the home position thereof at block B**250**;

determining a return energy used to return the first contact member **230** to the home position thereof at block B**255**;

determining an energy difference between the travel energy and the return energy for the first contact member **230** at block B**260**;

selecting, at block B**265**, based on energy difference of the first contact member **230**, a media weight class from the predetermined group of media weight classes; and

adjusting, at block B**270**, an operating parameter of the imaging device **2** based in the selected media weight class.

In an imaging device for forming at a print engine therein an image on a media sheet moveable along a media path therein, a method M**30** for determining a media weight class is illustrated in FIGS. **20**A-**20**B. Method M**30** comprises:

feeding, at block B**300**, a media sheet into a nip **123** formed between a pair of feed rolls **121** positioned along the media path prior to the print engine;

positioning, at block B**305**, one of a leading edge and a trailing edge of the media sheet at a first distance from the nip;

positioning, at block B**310**, a translateable first contact member **230** intermediate one of the leading edge and the trailing edge at a second distance from the nip **123** that is less than the first distance, the first contact member **230** translateable from a home position thereof through to a first travel distance;

positioning, at block B**315**, a translateable second contact member **330** intermediate the first contact member and the nip **123**;

determining, at block B**320**, whether or not one of the leading edge and trailing edge of the media sheet is in position;

when it is determined that one of the leading edge and trailing edge of the media sheet is in position:

translating, at block B**325**, using a first reversible motor **321**, the second contact member **330** from a home position into contact with the media sheet in a direction transverse to a media plane P of the media sheet along a second travel distance;

determining, at block B**330**, whether or not the second contact member **330** has translated the second travel distance;

when it is determined that the second contact member **330** has not translated the second travel distance, determining, at block B**335**, whether or not a motor current maximum threshold for first reversible motor **321** has been exceeded;

when it is determined that the motor current maximum threshold of the first reversible motor **321** has not been exceeded:

continuing, at block B**340**, translating the second contact member **330** until the second travel distance has been reached;

when, at block B**330**, it has been determined that the second contact member has reached the second travel distance, then determining, at block B**345**, a travel energy used for the second contact member **330** to reach the second travel distance;

reversing, at block B**350**, the first reversible motor **321** and returning the second contact member **330** to the home position thereof;

determining, at block B**355**, a return energy used to return the second contact member **330** to the home position thereof;

determining, at block B**360**, an energy difference between the travel energy and the return energy for the second contact member **330**; and

based on energy difference of the second contact member **330**, selecting, at block B**365**, a media weight class from the predetermined plurality of media weight classes;

when, at block B**335** it is determined that the motor current maximum threshold of the first reversible motor **321** has been exceeded, reversing, at block B**370**, the first reversible motor **321** and returning the second contact member **330** to the home position thereof;

translating, at block B**380**, the first contact member **230** using a second reversible motor **221** from its home position into contact with the media sheet in a direction transverse to the media plane P along the first travel distance;

determining, at block B**385**, whether or not the first contact member **230** has translated the first travel distance;

when it is determined that the first contact member **230** has not translated the first travel distance, determining, at block B**390**, whether or not a motor current maximum threshold for the second reversible motor **221** has been exceeded;

when it is determined that the motor current maximum threshold for the second reversible motor **221** has been exceeded, selecting, at block B**395**, a heaviest media weight class, reversing the second reversible motor **221** and returning the first contact member **230** to the home position thereof;

when, at block B**390**, it is determined that the motor current maximum threshold has not been exceeded by the second reversible motor **221**, continuing, at block B**400**, translating first contact member **230** and redetermining whether or not the first contact member **230** has translated the first travel distance,

upon determining that the first contact member **230** has traveled the first travel distance, determining, at block B**405**, a travel energy used for the first contact member **230** to reach the first travel distance;

reversing, at block B**410**, the second reversible motor **221** and returning the first contact member **230** to the home position thereof;

determining, at block B**415**, a return energy used to return the first contact member **230** to the home position thereof;

determining, at block B**420**, an energy difference between the travel energy and the return energy for the first contact member **230**; and

selecting, at block B**425**, based on energy difference of the first contact member **230**, a media weight class.

With method M**30**, a print engine, such as print engine **4** may be provided downstream of the nip **123**, and, upon determination of a media weight class, an operating parameter of the print engine **4** or imaging device **2** may be adjusted as previously described with respect to methods M**10** and M**20**. The motor current threshold for the first and second motors may be the same or can differ. It may be advantageous for the media stiffness assembly being used with the shorter beam length to have a lower current threshold value.

The foregoing description of embodiments has been presented for purposes of illustration. It is not intended to be exhaustive or to limit the present disclosure to the precise steps and/or forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be defined by the claims appended hereto.

What is claimed is:

1. In an imaging device for forming an image on a media sheet moveable along a media path therein, a method for determining a media weight, the method comprising:

feeding a media sheet into a nip formed between a pair of feed rolls positioned along the media path;

positioning a first translateable contact member at a first distance from the nip path, the first translatable contact member being positioned to provide, when translated, a force component normal to the media path of the imaging device;

positioning an edge of the media sheet beyond the position of the first translateable contact member at a second distance from the nip that is greater than the first distance;

translating the first translateable contact member from a home position thereof a first travel distance into contact with the media sheet;

determining an amount of travel energy used to translate the first translateable contact member the first travel distance;

returning the first translateable contact member to the home position thereof;

determining the amount of return energy used to return the first translateable contact member to the home position thereof;

determining an energy difference between the amounts of travel energy and return energy for the first translateable contact member; and,

selecting, based on the energy difference for the first translateable contact member, a media weight.

2. The method of claim **1** wherein selecting a media weight further comprises selecting one media weight class from a plurality of predetermined plurality of media weight classes.

3. The method of claim **1** wherein selecting a media weight further comprises selecting one media weight from a predetermined continuum of media weights from about 45 grams/meter^2 to about 500 grams/meter^2.

4. The method of claim **1** wherein the first translateable contact member extends substantially across the width of the media path.

5. The method of claim **1** further comprising:

providing a print engine downstream of the feed nip; and,

adjusting at least one operating parameter of the imaging device based on the selected media weight.

6. The method of claim **5** wherein the at least one operating parameter is selected from group of operating parameters consisting of: a media speed within the print engine, a duplex control scheme, a fuser temperature, a transfer voltage, an output location, and a finishing process.

7. The method of claim **1** wherein translating the first translateable contact member further comprises

attaching the first translateable contact member to a translating mechanism;

operatively coupling a reversible drive mechanism to the translating mechanism; and,

operatively coupling a position encoder to the reversible drive mechanism,

wherein rotating the drive mechanism in a first direction moves the translating mechanism to translate the first translateable contact member from the home position thereof toward the media sheet, and rotating the drive mechanism in a second direction moves the translating mechanism to translate the first translateable contact member to return to the home position thereof, and, further wherein, the position encoder provides a signal representative of the position of the first translateable contact member from the home position thereof through to the first travel distance.

8. The method of claim **1** wherein determining the travel energy of the first translateable contact member comprises:

providing a motor energized by a motor driver using a pulse width modulation duty cycle, the motor being operatively coupled to the first translateable contact member for translating the first translateable contact member between the home position thereof and the first travel distance;

at each time interval of a plurality of predefined time intervals occurring during translating the first translateable contact member from the home position thereof through to the first travel distance:

measuring a motor current when translating the first translateable contact member from the home position thereof through the first travel distance;

calculating a motor voltage by calculating a product of the pulse width modulated duty cycle and a power supply voltage; and

calculating an instantaneous input power value to the motor by calculating the product of the motor current and the estimated motor voltage;

and

upon the first translateable contact member reaching the first travel distance, calculating the travel energy by summing the calculated instantaneous input power value determined for each time interval of the plurality of predefined time intervals that occurred while translating the first translateable contact member from the home position thereof through to the first travel distance.

9. The method of claim **8** wherein determining the return energy of the first translateable contact member comprises:

at each time interval of a plurality of predefined time intervals occurring while translating the first translateable contact member through the first travel distance back to the home position thereof:

measuring the motor current when translating the first translateable contact member back to the home position thereof;

calculating the motor voltage by calculating the product of the pulse width modulated duty cycle and a power supply voltage; and,

calculating an instantaneous input power value to the motor by calculating the product of the motor current and the estimated motor voltage;

and,

upon the first translateable contact member returning to the home position thereof, calculating the return energy by summing the calculated instantaneous input power value determined for each time interval of the plurality of predefined time intervals that occurred while translating the first translateable contact member to return to the home position.

10. The method of claim **1** further comprising:

positioning a second translateable contact member intermediate the feed nip and the first translateable contact member and transverse to the media path; and

prior to translating the first translateable contact member:

translating the second translateable contact member from a home position thereof along a second travel distance into contact with the media sheet; and,

determining an amount of travel energy used to translated the second translateable contact member through the travel distance and determining whether or not the amount of travel energy used during translating of the second translateable contact member along the second travel distance exceeds a threshold value; and, on determining that the threshold value is not exceeded:

returning the second translateable contact member to the home position thereof;

determining an amount of return energy used to return second translateable contact member to the home position thereof;

determining an energy difference between the amounts of travel energy and return energy for the second translateable contact member; and

selecting, based on the energy difference for the second translateable contact member, a media weight.

11. The method of claim **10** wherein determining the travel energy of the second translateable contact member comprises:

providing a motor energized by a motor driver using a pulse width modulation duty cycle, the motor being operatively coupled to the second translateable contact member for translating the second translateable contact member between the home position thereof and the second travel distance;

at each time interval of a plurality of predefined time intervals occurring while translating the second translateable contact member from the home position thereof through the second travel distance:

measuring a motor current when translating the second translateable contact member from the home position thereof through the second travel distance;

calculating a motor voltage by calculating a product of the pulse width modulated duty cycle and a power supply voltage; and,

calculating an instantaneous input power value to the motor by calculating the product of the motor current and the estimated motor voltage;

and,

upon the second translateable contact member reaching the second travel distance, calculating the travel energy of the second translateable contact member by summing the calculated instantaneous input power value determined for each time internal in the plurality of predefined time intervals that occurred while translating the second translateable contact member from the home position thereof through the second travel distance.

12. The method of claim **11** wherein determining the return energy of the second translateable contact member comprises:

at each time interval of a plurality of predefined time intervals occurring while translating the second translateable contact member through the second travel distance back to the home position thereof:

measuring the motor current when translating the second translateable contact member back to the home position thereof;

calculating the motor voltage by calculating the product of the pulse width modulated duty cycle and a power supply voltage; and,

calculating an instantaneous input power value to the motor by calculating the product of the motor current and the estimated motor voltage;

and,

upon the second translateable contact member returning to the home position thereof, calculating the return energy by summing the calculated instantaneous input power value determined for each time interval of the plurality of predefined time intervals that occurred while translating the second translateable contact member to return to the home position thereof.

13. The method of claim **10** wherein the second travel distance is shorter than the first travel distance.

14. The method of claim **10** wherein selecting a media weight further comprises selecting one media weight class from a plurality of predetermined media weight classes.

15. The method of claim **10** wherein selecting a media weight further comprises selecting one media weight from a predetermined continuum of media weights.

16. The method of claim **10** wherein, on determining that the threshold value is exceeded, repeating the acts of: translating the first translateable contact member from the home position thereof through the first travel distance; determining an amount of travel energy used to translate the first translateable contact member; returning first translateable contact member to the home position thereof, determining the amount of return energy for the first translateable contact member, determining the energy difference between the amounts of travel energy and return energy for the first translateable contact member, and, selecting, based on the energy difference for the first contact member, a media weight class.

17. The method of claim **10** further comprising adjusting at least one operating parameter of the imaging device based on the selected media weight class.

18. The method of claim **17** wherein the at least one operating parameter is selected from group consisting of a media speed within the image device, a duplex control scheme, a fuser temperature, a transfer voltage, an output location, and a finishing process.

19. In an imaging device for forming at a print engine therein an image on a media sheet moveable along a media path therein, a method for determining a media weight class, the method comprising:

feeding a media sheet into a nip formed between a pair of feed rolls positioned along the media path prior to the print engine;

positioning an edge of the media sheet at a first distance from the nip;

positioning a first translateable contact member intermediate the nip and the edge of the media sheet at a second distance from the nip that is less than the first distance;

determining whether or not the edge of the media sheet is in position;

when it is determined that the edge of the media sheet is in position:

translating, using a reversible motor, the first translateable contact member from a home position thereof along a travel distance into contact with the media sheet in a direction transverse to a media plane of the media sheet;

determining whether or not the first translateable contact member has translated the travel distance; and,

when it is determined that the first translateable contact member has not translated the travel distance, determining whether or not a motor current maximum threshold has been exceeded;

when it is determined that the motor current maximum threshold has been exceeded, selecting a heaviest media weight class and reversing the motor and returning the first translateable contact member to the home position thereof; and,

when it is determined that the motor current maximum threshold has not been exceeded:

continuing translating first translateable contact member to the travel distance;

determining a travel energy used for the first translateable contact member to reach the travel distance;

reversing the motor and returning the first translateable contact member to the home position thereof;

determining a return energy used to return the first translateable contact member to the home position thereof;

determining an energy difference between the travel energy and the return energy for the first translateable contact member; and,

selecting, based on the energy difference of the first contact member, a media weight class from a plurality of predetermined media weight classes.

20. The method of claim **19** further comprising adjusting at least one operating parameter of the imaging device based on the selected media weight class.

21. The method of claim **20** wherein the at least one operating parameter is selected from group consisting of a media speed within the print engine, a duplex control scheme, a fuser temperature, a transfer voltage, an output location, and a finishing process.

22. In an imaging device for forming at a print engine therein an image on a media sheet moveable along a media path therein, a method for determining a media weight class, the method comprising:

feeding a media sheet into a nip formed between a pair of feed rolls transversely positioned along the media path prior to the print engine;

positioning one of a leading edge and a trailing edge of the media sheet at a first distance from the nip;

positioning a first translateable contact member intermediate one of the leading edge and the trailing edge at a second distance from the nip that is less than the first distance, the first translateable contact member translateable from a home position thereof through to a first travel distance;

positioning a second translateable contact member intermediate the first translateable contact member and the nip;

determining whether or not one of the leading edge and trailing edge of the media sheet is in position; and

when it is determined that one of the leading edge and trailing edge of the media sheet is in position:

translating, using a first reversible motor, the second translateable contact member from a home position thereof into contact with the media sheet in a direction transverse to a media plane of the media sheet along a second travel distance;

determining whether or not the second translateable contact member has translated the second travel distance;

when it is determined that the second translateable contact member has not translated the second travel distance, determining whether or not a motor current maximum threshold has been exceeded by the first reversible motor;

when it is determined that the motor current maximum threshold of the first reversible motor has not been exceeded:

continuing translating the second translateable contact member and redetermining whether or not the second translateable contact member has translated the second travel distance, and, upon determining that the second translateable contact member has traveled the second travel distance:

determining a travel energy used for the second translateable contact member to reach the second travel distance;

reversing the first reversible motor and returning the second translateable contact member to the home position thereof;

determining a return energy used to return the second translateable contact member to the home position thereof;

determining an energy difference between the travel energy and the return energy for the second translateable contact member; and

based on the energy difference of the second translateable contact member, selecting a media weight class from a predetermined plurality of media weight classes;

when it is determined that the motor current maximum threshold of the first reversible motor has been exceeded:

returning the second translateable contact member to the home position thereof;

translating the first translateable contact member using a second reversible motor from a home position thereof into contact with the media sheet in a direction transverse to the media plane along the first travel distance;

determining whether or not the first translateable contact member has translated the first travel distance;

when it is determined that the first translateable contact member has not translated the first travel distance, determining whether or not a motor current maximum threshold for the second reversible motor has been exceeded by the second reversible motor;

when it is determined that the motor current maximum threshold for the second reversible motor has been exceeded, selecting a heaviest media weight class from the predetermined plurality of media weight classes, reversing the second reversible motor and returning the first translateable contact member to the home position thereof;

when it is determined that the motor current maximum threshold has not been exceeded by the second reversible motor, continuing translating first translateable contact member and redetermining whether or not the first translateable contact member has translated the first travel distance, and, upon determining that the first translateable contact member has traveled the first travel distance:

determining a travel energy used for the first translateable contact member to reach the first travel distance;

reversing the second reversible motor and returning the first translateable contact member to the home position thereof;

determining a return energy used to return the first translateable contact member to the home position thereof;

determining an energy difference between the travel energy and the return energy for the first translateable contact member; and

selecting, based on the energy difference of the first translateable contact member, a media weight class from the predetermined plurality of media weight classes.

23. The method of claim 22 wherein the first reversible motor and second reversible motor are the same motor operatively coupled to the first and second translateable contact members.

24. The method of claim 22 further comprising adjusting at least one operating parameter of the imaging device based on the select media weight class.

25. The method of claim 24 wherein the at least one operating parameter is selected from group consisting of a media speed within the print engine, a duplex control scheme, a fuser temperature, a transfer voltage, an output location, and a finishing process.

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